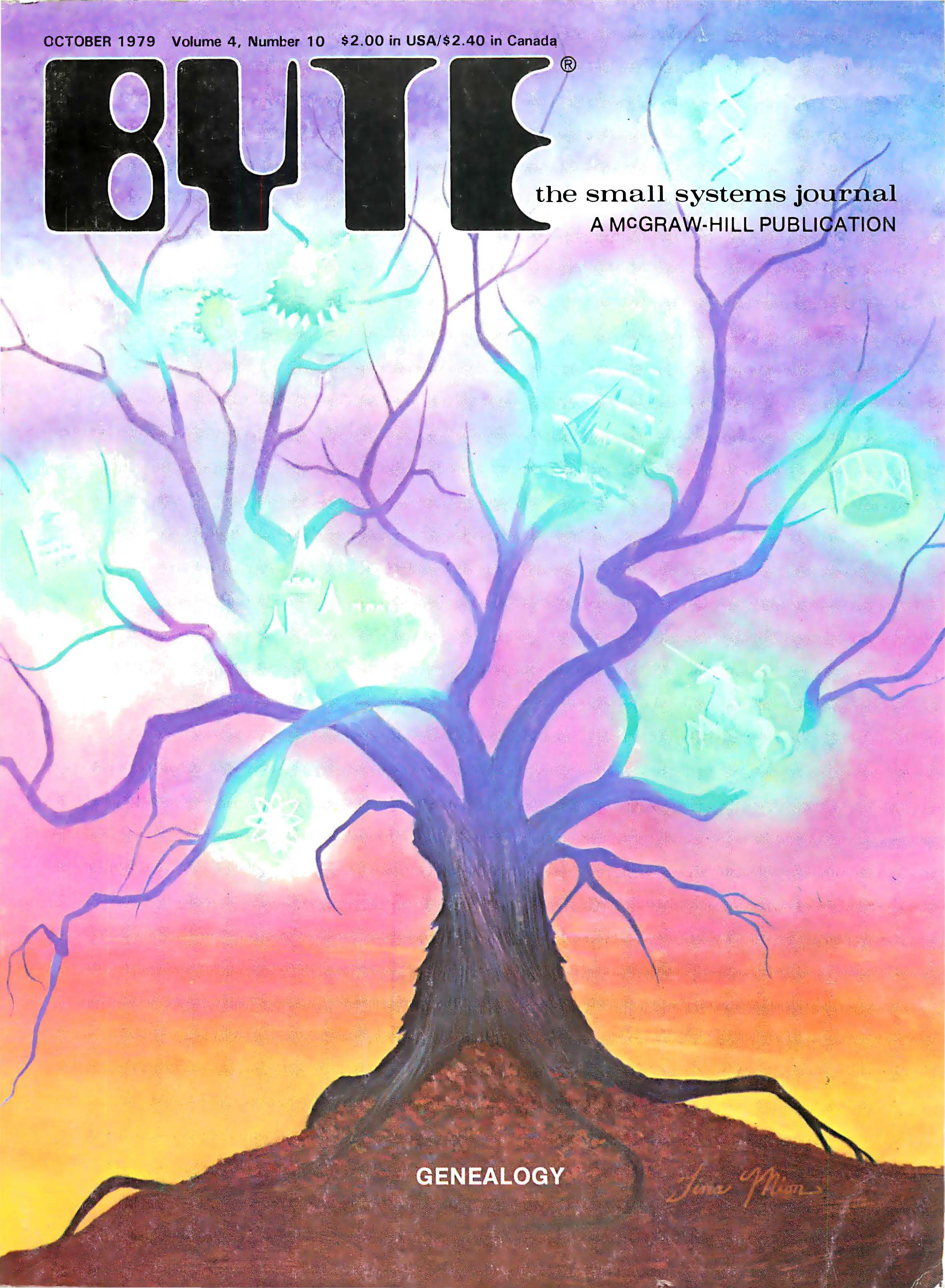


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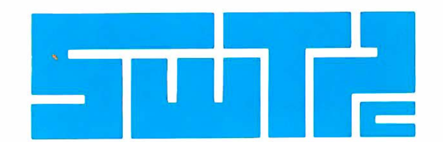
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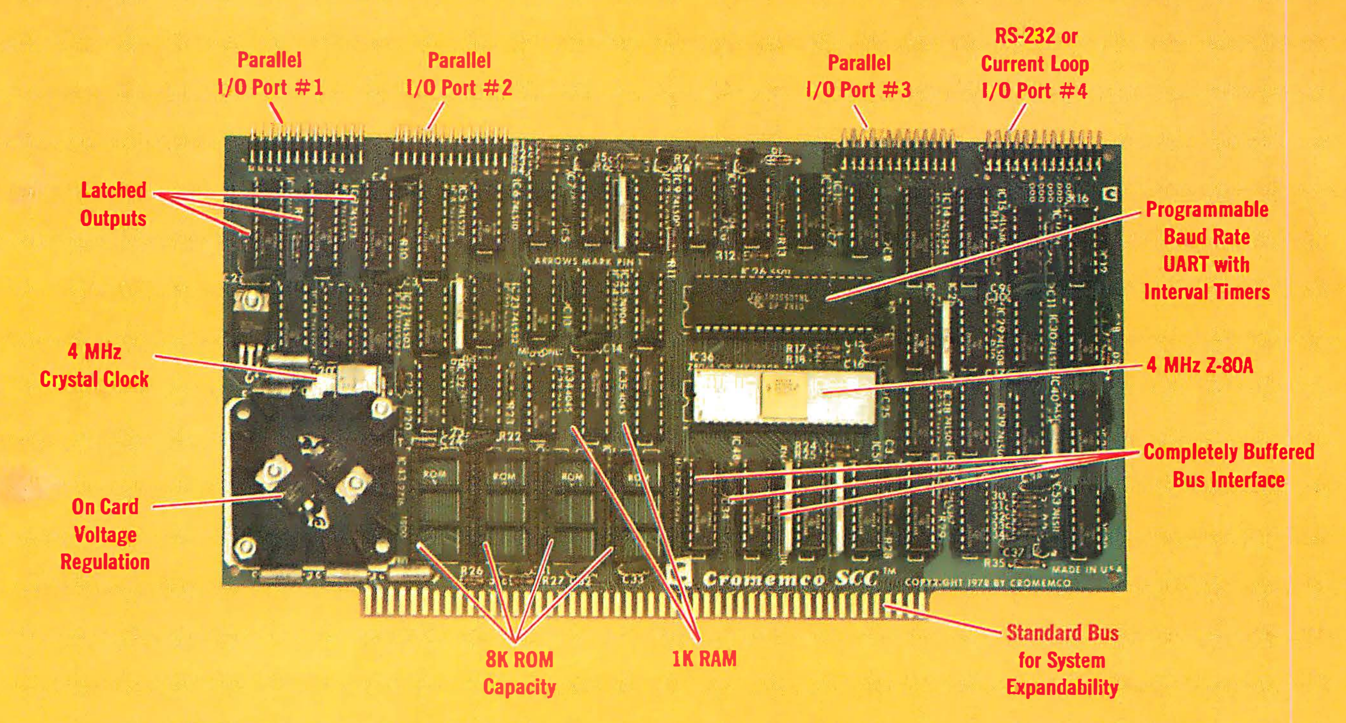
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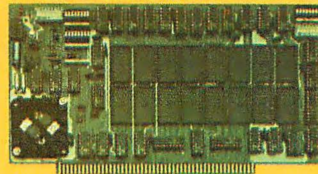
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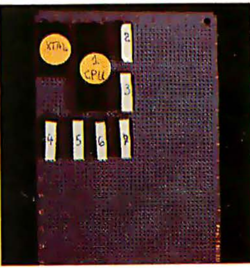


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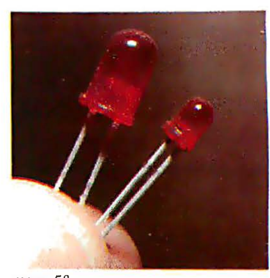
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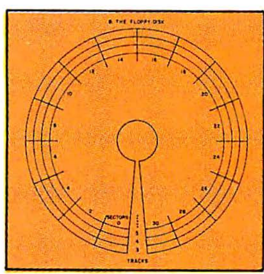
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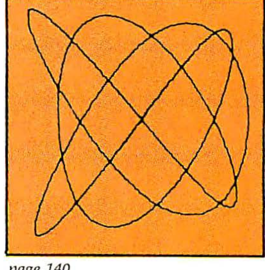
Foreground



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Background



Nucleus

Cover Art: **Genealogy** *by Tina Mion*

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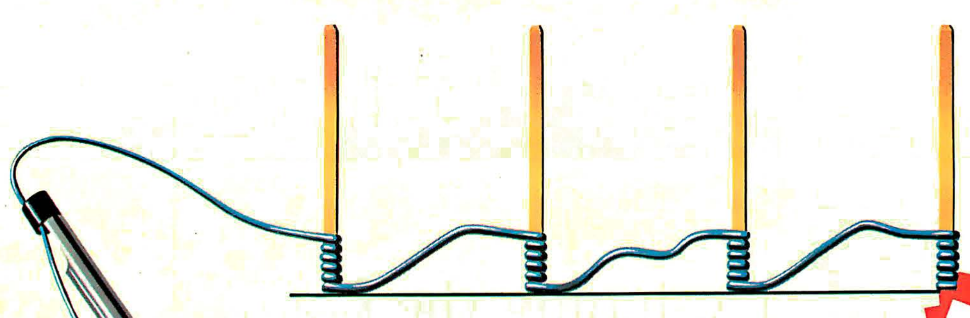
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In This BYTE



About the Cover

This month's cover theme is provided by an article on using one's personal computer for personal genealogy tasks, "Genealogy" by Tina Mion. Taking off on this theme, autumn colors, and the day of the great pumpkin at the end of October, artist Tina Mion has created an autumnal tree with some ghostly leaves reflecting a history of science and technology.



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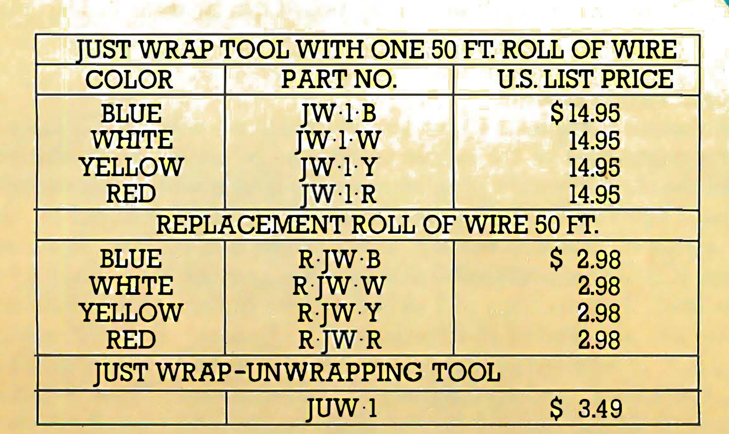
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Editorial

Designing the Logic of the System — Processor Board Design,

Part 2: Will the Parts Fit on the Board?

by Carl Helmers

This month's editorial is the latest in a series begun last July describing a new homebrew 6809 personal computer system. The general backplane design was presented last month. This month we describe the processor board. Its ideal features would include:

- 6809 processor (40 pins) and buffers for external signals.
- 4 K bytes of 2708 read-only memory for systems software.
- Interrupt flags for lines IO through I7 and peripheral interface adapter (PIA) port with its interrupt request (IRQ) output tied to the fast interrupt request (FIRQ) input of the processor.
- If it fits, logic for a primary serial terminal port and connector.

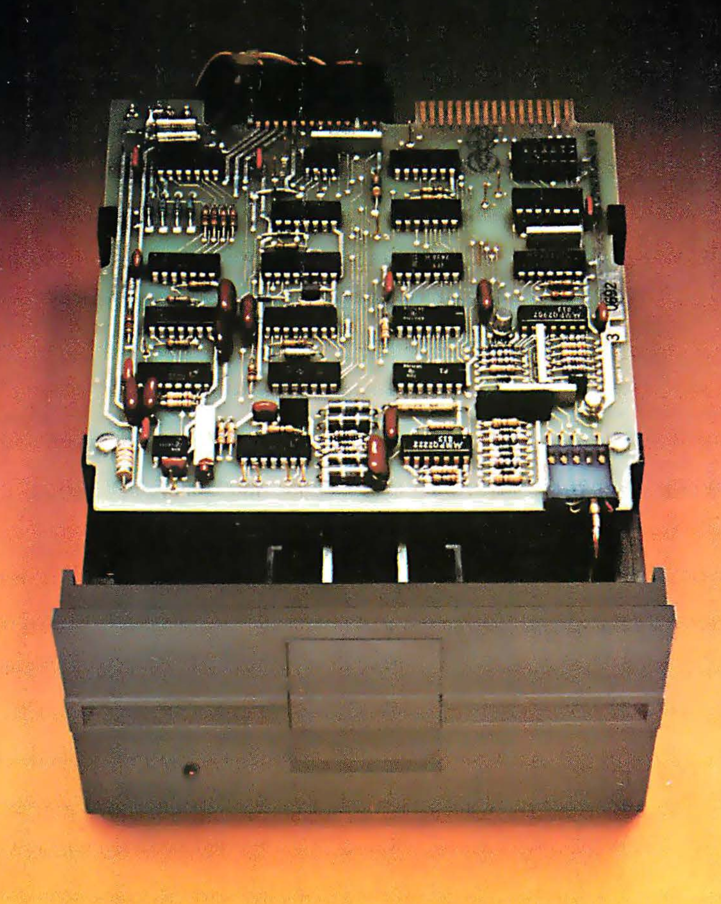
In order to find out whether this is a reasonable allocation of function for the 4.5 by 9.0 inch area of 1 card in the system, we must systematically estimate the parts required for each of these segments of the logic. The series of photographs 1a through 1d show how integrated circuit sockets are used as markers in the layout of the board space requirements. Each socket has a sticky paper label attached which is marked with its assigned number. Placement of the socket on an unused prototyping board can be done to help plan the layout.

Processor Logic Requirements

The processor alone occupies a 40-pin socket, which we will call IC1 since it is the most important part of the whole computer. In addition, the discrete components of the clock crystal's parallel-resonant circuit will conservatively require the space equivalent of 1 24-pin socket. The buffers required for the data bus are a pair of DM8833 tristate, bidirectional bus buffers. These are labeled IC2 and IC3. Three SN74367 tristate drivers provide the buffering for the 16 address lines. Two sections of 1 of the address buffer chips remain unused. These circuits are labeled IC4 through IC6. Another SN74367, which will be labeled IC7, is required so that 3 of its 6 buffer sections can be used for the ENABLE, QENABLE, and RW signals of the backplane. These 7 socket positions plus the 1 24-pin dummy for the clock crystal and related discretes are shown in position for layout purposes in photo 1a.

In order to provide a uniform connection to the backplane bus, every major segment of the system will be isolated by a set of bus buffers, such as the DM8833 parts which are included in the processor section. For the remainder of the logic on the processor board which will interface to the data bus, a pair of DM8833 parts labeled IC8 and IC9 will suffice to define a local bus extension. This local bus extension will service the 2708 read-only memory, the peripheral interface adapter used for interrupt logic, and the asynchronous communications interface adapter (ACIA) used for the primary terminal of the system.

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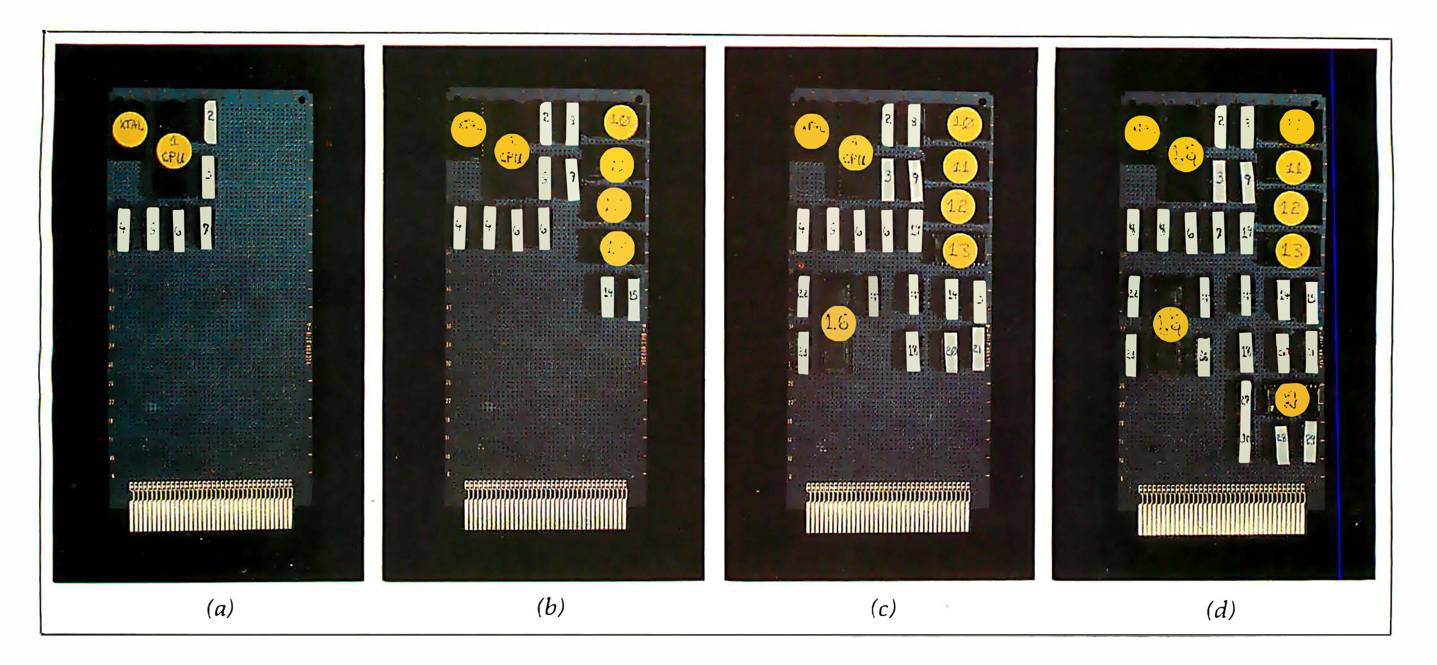
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(a) (b) (c) (d)

Photo 1: By using a prototyping board as a matrix, it is easy to mark wire-wrap sockets with logical identification numbers and use them as markers in creating a layout of parts for the board. This series of photographs documents the discussion of the main parts of the central processor card of the new 6809 homebrew system.

(a) The first segment of the layout is the processor itself and its crystal timing standard, data bus extension buffers, and address buffers.

(b) The second segment of the layout adds 4 read-only memory circuits and 2 socket positions needed to decode and select the individual 1024 byte segments (10, 11, 12 and 13).

(c) The third segment of the layout process adds a peripheral port (16) and logic associated with 8 interrupt flags. Miscellaneous logic at this stage includes decoding of the address of the parallel port.

(d) Finally, the logic of the central processor card is completed with the addition of a communications adapter, 25, and associated decoding and buffer circuits.

The next logic item to consider is the read-only memory bank. Four 2708 parts will be used to store up to 4 K (4096) bytes total. This memory bank will contain the resident systems software of the machine, including the fixed handlers for the 3 different classes of interrupts, the power on reset routines, etc. We will thus require 4 24-pin sockets for these integrated circuits, IC10, IC11, IC12 and IC13. In addition to the requirements of the read-only memory parts, we also require logic to decode the high-order 6 bits of an address and the read signal. The read-only memory bank must overlap addresses FFF0 to FFFF in order to provide the vector addresses for interrupts. Thus decoding logic should be provided to place this 4 K segment of memory at the upper end of the memory address space of the 6809, locations F000 to FFFF. Decoding the high-order 4 bits of addressing can be done with one half of a 7420 integrated circuit, IC14. The active-low output of this 7420, along with the RW signal and the next 2 address bits (A11 and A10) can then be decoded by a single 7442 integrated circuit, IC15, to produce a 1 of 4 selection for the active-low chip select lines of the 2708 read-only memory parts. Photo 1b shows the tentative layout of the board with the addition of the read-only memory parts and the local bus extension buffers.

The handling of interrupts in this processor will be provided by use of a single 6821 peripheral interface adapter which will be used to read a bank of 8 set-reset flip-flops found in a pair of SN74279 integrated circuits. The 6821 called IC16 will require address decoding for its location in memory address space. This leads to the problem of allocating address space within the whole system, for the parts needed to decode an address differ depending upon what address is chosen.

So far, the only address commitment we have made is the placement of the read-only memory segment at addresses F000 to FFFF so that it overlaps the hardware requirements of interrupt vectors at FFF0 to FFFF. Let us build an address space allocation which takes into account some of the future expansion possibilities:

E000-->FFFF read-only memory (upper 4 K implemented initially).
D000-->DFFF I/O (input/output) and peripheral addresses (sparsely populated).
0000-->CFFF 52 K main memory space (lower 16 K implemented initially).

The decision to allocate 8 K bytes for read-only memory space is a conservative one which allows for the addition of up to 4 more 2708 sockets on another board. The 4096 byte address space reserved for I/O will be more than adequate. The balance of the 64 K address space is left to the main memory.

Within the I/O address space of D000 to DFFF, let us arbitrarily decide that all parallel I/O will be via peripheral interface adapters, and that these parts will be located at address D000 and continuing through D0FF. Since each 6821 requires 4 address locations for its interface, this gives a maximum of 64 such parallel ports in the

system. At the same time, thinking ahead, let us allocate 6850 asynchronous communications adapters to address locations D100 through D1FF. This reserves 128 logical slots for potential 6850 parts — again far in excess of what will actually be implemented. The main reason for making these allocations start at even hexadecimal digit boundaries (D0 and D1 in the high-order) is to simplify interpretation of machine code and references to addresses in the hand-assembled systems software to be created later. We could just as easily have compressed the allocations into a contiguous segment of address space without holes.

After this detour into address space allocation, we can return to the problem of estimating the parts needed to decode the 6821 peripheral interface adpater used for the interrupt flag input. First, we note that the decoding of the D0xx and D1xx addresses for the 2 peripherals on this board will share common logic for 7 bits of high-order information. These 7 bits include 3 which must be logical 1 and 4 which must be logical 0. Two 8-input 7430 NAND gates, IC17 and IC18, will be used to form the high-order decoding logic, with 1 7404 hex-inverter package (IC19) used to invert the 4 bits which must be logical 0. An additional 7404 section will be required for the D0 decode to invert bit line A8. The outputs of the 2 7430 parts are active-low selections of high-order addresses D0xx and D1xx.

Returning to the 6821 part, IC16, let us allocate its detail addresses as D000 to D003. The 2 register select inputs of the circuit will get connected to the low-order address lines, A0 and A1. We need to verify that all bits, A7 through A2, are 0 when these addresses are selected: to do this, logic of another 7404 inverter IC20 and a 7430 8-input NAND gate IC21 is required. The final result is the definition of 1 chip select input to the 6821 from the high-order address selection of D0 and a second chip select input from the low-order address selection from IC21.

With its addresses decoded, the 6821 now talks to the bus extension of the system, but we have one more item to consider: the 74279 interrupt flag chips and pull-up resistors. We will assign the numbers IC22 and IC23 to the flag registers, and assign the number IC24 to a 16-pin socket which will be used to hold 8 resistors which tie the 8 interrupt lines (I0-I7) up to +5 V when no input is present. Photo 1c shows a layout of the board after all the sockets connected with the interrupt peripheral interface adapter have been added, IC16 through IC24.

The one remaining device to consider is the addition of a 6850 asynchronous communications interface adapter which we will call IC25. This will be the terminal port through which initialization information will be sent in an American Standard Code for Information Interchange (ASCII) encoded form from the primary computer and mass storage device of the multiple processor system. In separate tests of the 6809 system, this port can be driven by a terminal, since the initialization sequences will use standard ASCII characters as opposed to a more compact binary form.

The address decoding for this port was begun in earlier considerations. We have a line decoding the D1 address of serial ports in the high-order, an output of IC18. With an asynchronous communications interface adapter, we have to decode 7 out of 8 low-order bits in order to assign the necessary 2 addresses. Using addresses D100 and D101 for this port, we need a single 7430 8-input NAND gate IC26 for the low-order selection. The inverted states of address bits A2 through A7 are shared with the decoding of the 6821 part discussed earlier, and inversion of the A1 bit can use a spare section from either the 7420 IC14 or one of the hex-inverter packages.

Also required for the serial interface is some form of a socket header for a D connector attached to a cable and level conversion integrated circuits. Thus IC27 which is an MC1488 and IC28 which is an MC1489 provide our level conversion. IC29 is a socket devoted to attachment of the cable to the D connector. By popping off the plastic cover on a wire-wrap socket, such as IC29, it is possible to insert a small (#20 gauge) stranded wire into the contacts of the socket. This wire can then be carefully soldered so that no bridges to the next pin occur, or every other pin can be assigned to this I/O function where only a subset of the 14 or 16 pins is necessary. Photo 2 illustrates this point of fabrication by way of an example.

There is one minor detail which still remains with respect to the communications interface: we need a clock which can supply a frequency of 16 times the data rate of 19,200 bps, or 307.2 kHz. It turns out that given a 5 MHz central processor clock source, we come very close to the desired data rate by simply dividing by 16 to get 312.50 kHz. The error in this frequency is 1.7%, with respect to the proper clock of 307.20. Will this work? Yes, for the

Text continued on page 14

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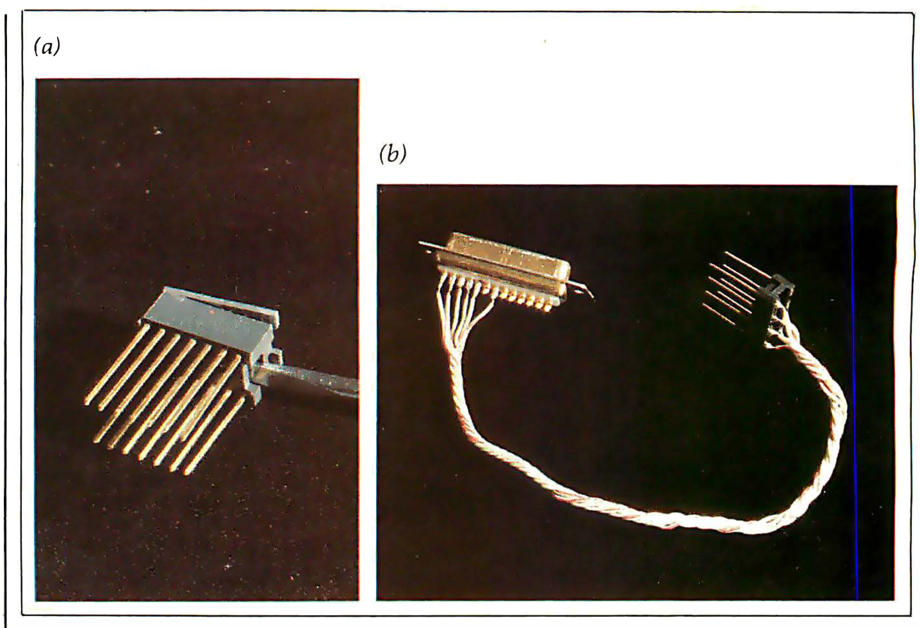


Photo 2: A good technique for interfacing wire-wrap cards with the external world is to use a socket as a header. Here is an example of how a 14-pin socket has its top cap being popped off (a). Then (b), it is possible to carefully insert small stranded wires which are firmly soldered in place and run the wires to the external device. After popping the top, it is possible to very carefully remove every other pin in order to space out the terminations and help eliminate the possibility of a solder bridge. Here we have taken a 14-pin socket and wired it with the following pin assignments for an RS-232C female D connector:

RS-232C pin	to	Socket header pin	
1	<------------------------------------>	1	chassis ground
2	<------------------------------------>	3	output
3	<------------------------------------>	5	input
4	<------------------------------------>	7	request to send
5	<------------------------------------>	8	clear to send
7	<------------------------------------>	10	signal ground

id	pins	type	comments
IC1	40	6809	microprocessor
IC2	16	DM8833	tristate bidirectional buffers D0-D3
IC3	16	DM8833	tristate bidirectional buffers D4-D7
IC4	16	74367	tristate buffers A0-A6
IC5	16	74367	tristate buffers A7-A11
IC6	16	74367	tristate buffers A12-A15
IC7	16	74367	tristate buffers ENABLE,QENABLE,RW
IC8	16	DM8833	tristate bidirectional buffers D0-D3 local bus extension
IC9	16	DM8833	tristate bidirectional buffers D4-D7 local bus extension
IC10	24	2708	read-only memory, F000-F3FF
IC11	24	2708	read-only memory, F400-F7FF
IC12	24	2708	read-only memory, F800-FBFF
IC13	24	2708	read-only memory, FC00-FFFF
IC14	14	7420	
IC15	16	7442	
IC16	40	6821	peripheral interface adpater, D000-D003 interrupt port
IC17	14	7430	high-order decode select for IC16
IC18	14	7430	high-order decode select for IC25
IC19	14	7404	
IC20	14	7404	
IC21	14	7430	low-order decode fo IC16
IC22	16	74279	interrupt flag latch, I0-I3
IC23	16	74279	interrupt flag latch, I4-I7
IC24	16	5 K ohm	resistors for interrupt line pullups
IC25	24	6850	asynchronous communications adapter, D100-D101
IC26	14	7430	low-order decode for IC25
IC27	14	MC1488	TTL to RS-232C line drivers
IC28	14	MC1489	RS-232C to TTL line receivers
IC29	14	---	14 pin socket for RS-232C cable termination
IC30	14	7473	divide by 4 for communications clock rate

Table 1: List of integrated circuits for new 6809.

Text continued from page 10:

total time of 1 character, the error in the last bit sent is what counts. A character is a sequence of 11 bit times; 1 bit has a width of 1/11th or 9.1% of the total time involved. The worst case of the last stop bit in the 11 bit sequence (start bit, 8 data bits, 2 stop bits) will have the full timing error of 1.7% of the total period for 1 character. We could probably get away with as much as a 5% to 6% error in the frequency of the data rate clocks.

Thus by providing a 2-bit divider in the form of a 7473 circuit IC30, we get the clock needed for the communications circuit from the crystal controlled 1.25 MHz ENABLE output of the processor. It turns out that the serendipity of the 5 MHz junk box crystals really worked in planning this system. If it is necessary to use a 4 MHz crystal for the system because the 6809 will not run 25% faster than its specification then use of a divisor of 13 instead of 16 produces a data rate of 307.7 kHz which is only 0.2% off the desired 307.2 kHz rate. In this case of a 4 MHz source, a 74193 would be used instead of a 7473 for IC30, and input to the 74193 would be taken from the tank circuit through a relatively high-impedance buffer.

This completes the preliminary consideration of the central processor card design. As can be seen in photo 1d, the 30 integrated circuits sockets required for this central processor design fit the space available on the prototyping card with room to spare. Table 1 summarizes the integrated circuit and socket list as it stands now. This verbal discussion ahead of drawing a diagram of the circuit is an experiment. In past designs, I have jumped right in to the drawing of a logic diagram. The actual circuit diagram has not been drawn as of this writing (June 18 1979), and 1 or 2 integrated circuits may be necessary to provide an additional random logic gate or inverter beyond those anticipated in this discussion.

In the next installment of this series on building a homebrew general purpose computer for use as a communications controller, we shall start with a verification of these design considerations as an actual diagram, then proceed to discuss construction and testing of this first card in the system. As emphasized in the earlier comments in this series, the timing of the publication of these notes depends upon the amount of spare time I have available to devote to this activity. The intent of this series is to show our readers how simple it is to assemble homebrew systems out of standard parts, using design information which is available in various publications put out by semiconductor manufacturers. ■

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a large (9 by 12 inch, 30.5 by 22.8 cm), self-addressed envelope, with 28 cents US postage affixed, to BYTE Author's Guide, 70 Main St, Peterborough NH 03458.

Articles which are accepted are purchased with a rate of up to $50 per magazine page, based on technical quality and suitability for BYTE's readership. Each month, the authors of the two leading articles in the reader poll (BYTE's Ongoing Monitor Box or "BOMB") are presented with bonus checks of $100 and $50. Unsolicited materials should be accompanied by full name and address, as well as return postage.

Letters

ULTRASONIC TRANSDUCERS LOCATED

Just a short note to ask for a helping hand and to let you know that your articles in BYTE are read and enjoyed.

In your article "Building a Computer Controlled Security System for Your Home"(March 1979 BYTE, page150) you showed a circuit for generation and detection of ultrasonic signals. Would you be so kind as to note a company or two that I could contact for transducers? I have an application for ultrasonics and need a little help in knowing where to write.

Thank you for your help, and again I enjoy your articles.

Tom Yocom, WA1RTD
21 Bayberry Rd
Acton MA 01720

Author Ciarcia Replies:

The particular transducers used in the March article are from MASSA in Hingham MA, I obtained them through Bullet Electronics, POB 401244E Garland, TX 75040, (214) 278-3553. I suggest calling them to determine price and availability. Since I usually purchase components in large quantities long before I actually need them for an article, I hesitate to quote a price and a definite source. The MASSA units had an output frequency of 23 kHz.

LONG DISTANCE COMMUNICATION

I saw your article in the May issue of BYTE ("Communicate on a Light Beam," page 32) and became very interested. I have an application which requires sending data up to a kilometer at speeds from 2000 to 9600 characters per second (cps). Your descriptions of the fiber optic cable and the light-emitting diode (LED) transmission circuits seem to be ideal, if they are cost effective.

Could you give more details of the distances which the circuits can drive and the addresses of the suppliers of the fiber optic components?

R H Fields
1 Wythegate
Riverside Rd
Staines, Middlesex
United Kingdom

Author Ciarcia Replies:

Realize, of course, that the circuits presented, while possibly usable in commercial applications, are presented more to introduce the reader to the concept of fiber optic communications than solve any particular application problem. Their usability in a 1 kilometer data link depends upon more than just the electronic parameters of the circuit. The laser probably can drive such a length, but cable losses and mechanical/optical connections are going to be an important factor in any success.

When you speak of 9600 cps that is approximately 100 k bits per second (bps) and is a reasonable transmission rate. However, response time of the receiver electronics is going to be much more critical than a 10 k bit rate. Given the length of cable as 1 kilometer, I would caution you that a certain intensity must be maintained at the ouput to achieve this response.

Rather than try to reinvent the wheel or try to second-guess the technical people who really know the field, I think you would be better off purchasing a commercial system. The following is a list of American companies which deal in fiber optics. I am sure they will have a cost-effective solution for you:

Corning Glass Works
Telecommunications Dept
Corning, NY 14830
(607) 974-8812

Dupont Co
Plastic Products and Resins Dept
Wilmington, DE 19898
(302) 774-7850

Fiberoptic Cable Corp
POB 1492
Framingham, MA 01701
(617) 875-5530

Galileo Electro-Optics Corp
Galileo Park
Sturbridge, MA 01618
(617) 347-9191

General Cable Corp
500 W Putnam Ave
Greenwich, CT 06830
(203) 661-0100

ITT
Electro-Optical Products Div
Roanoke, VA 24019
(703) 563-0371

Quartz Products Corp
688 Somerset St
Plainfield, NJ 07061
(201) 757-4545

Times Fiber Communications Inc
358 Hall Ave
Wallingford CT 06492
(203) 265-2361

Valtec Corp
Electro Fiberoptics Div
West Boylston, MA 01583
(617) 835-6083

For further descriptive information on the use of fiber optics I suggest you refer to the January 5, 1978 issue of EDN magazine and an article titled "Designer's Guide to Fiber Optics."

Text continued on page 18

North Star Horizon–
COMPUTER WITH CLASS

The North Star Horizon computer can be found everywhere computers are used: business, engineering, home — even the classroom. Low cost, performance, reliability and software availability are the obvious reasons for Horizon's popularity. But, when a college bookstore orders our BASIC manuals, we know we have done the job from A to Z.

Don't take our word for it. Read what these instructors have to say about the North Star Horizon:

"We bought a Horizon not only for its reliability record, but also because the North Star diskette format is the industry standard for software exchange. The Horizon is the first computer we have bought that came on-line as soon as we plugged it in, and it has been running ever since!"
— Melvin Davidson, Western Washington University, Bellingham, Washington

"After I gave a ½ hour demonstration of the Horizon to our students, the sign-ups for next term's class in BASIC jumped from 18 to 72."
— Harold Nay, Pleasant Hill HS, Pleasant Hill, California

"With our Horizon we brought 130 kids from knowing nothing about computers to the point of writing their own Pascal programs. I also use it to keep track of over 900 student files, including a weekly updated report card and attendance figures."
— Armando Picciotto, Kennedy HS, Richmond, California

"The Horizon is the best computer I could find for my class. It has an almost unlimited amount of software to choose from. And the dual diskette drives mean that we don't have to waste valuable classroom time loading programs, as with computers using cassette drives."
— Gary Montante, Ygnacio Valley HS, Walnut Creek, Calif.

See the Horizon at your local North Star dealer.

Circle 285 on inquiry card.

NorthStar

North Star Computers
1440 Fourth Street
Berkeley, Ca 94710
(415) 527-6950 TWX/TELEX 910-366-7001

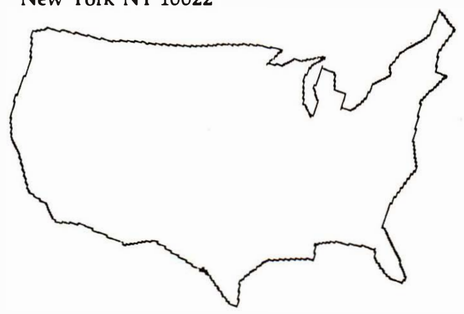
Text continued:

Phone Company Maps...

In reference to your article on map generation ("Computer Generated Maps," May 1979 BYTE, page 10) the telephone industry has gridded the US with a system of vertical and horizontal coordinators ("V & H"s). A discrete set of four digit "V & H"s for virtually every city, town and village is listed Federal Communications Commission tariffs.

"V & H" coordinates offer a quick and simple way to plot maps of American locations. For example, the program listing, at right, written for an Apple II, uses "V & H" coordinates for 72 border towns to sketch an outline map of the US.

Joseph P Garber
36 Sutton Place S
New York NY 10022



```
400  REM : BEGIN MAP ROUTINE
401  HGR2 : HCOLOR= 3
403  DEF  FN VF(A) =  INT ((A - 3
     300) / 35): DEF  FN HF(A) =
      INT ((A - 9250) /  - 35)
405  READ OO,ZZ
409  HCOLOR= 7
410  FOR I = 1 TO 72
420  READ XX,PP
430  HPLOT  FN HF(ZZ), FN VF(OO) TO
      FN HF(PP), FN VF(XX)
435 OO = XX:ZZ = PP
440  NEXT I
450  DATA  3303,1577,3884,1645,43
     19,2068,4623,2153
460  DATA 4759,2089,5055,2378,539
     5,2440,5648,2629
470  DATA  5704,2820,5367,2813,53
     68,3085,5061,3190
480  DATA  5027,3441,5437,3490,56
     95,3303,6017,3354
490  DATA  5788,3589,5372,3753,51
     08,3661,4862,3472
500  DATA  5079,3873,5113,4037,52
     91,4237,5352,4530
510  DATA  5006,4346,5074,4871,51
     26,5151,5475,6133
520  DATA   5861,7642,6036,8975,6
     191,              9238,6666,91
     01
530  DATA  7432,9158,7582,9113,79
     05,9087,8266,8962
540  DATA   8492,8719,9140,9293,9
     227,7920             ,9482,76
     13
550  DATA  9385,7171,9466,6182,92
     32,5655,9505,4370
560  DATA   9406,4493,9882,3766,9
     8             65,3606,9437,37
     00
570  DATA  9096,3466,8832,3276,85
     64,2425,8296,2481
580  DATA  8097,2097,8091,1818,80
     06,1271,8203,1206
590  DATA  8447,0840,8439,0543,83
     51,0527,7883,0946
600  DATA  7565,1280,7047,1264,66
     21,1119,6889,1102
610  DATA  5815,1256,5073,1348,47
     39,1178,4424,1017
620  DATA  4422,1249,4300,1302,41
     21,1334,3577,1131
630  DATA  3303,1577
```


5 BYTE CONVERSION

The "5 Byte Hexadecimal to ASCII Converter" described by Ashwin L Doshi (June 1979 BYTE, page 208) will work on the 8080, but not on the 8085 or Z80. As Doshi points out, the routine depends on the carry and the auxiliary carry being reset at the start of the routine. In practice, the conversion routine is preceded by an instruction ANI 0FH to mask off the upper 4 bits so that only the remaining 4 bits of the byte to be converted are passed to the routine. In both the 8085 and the Z80, however, the logical AND instruction *sets* this flag. The well-known 6-byte routine functions properly on both the 8085 and Z80.

Robert G Durnal
POB 68
Junior WV 26275

INFORMATION WANTED

I have a Heath microcomputer that I am using for market research. I am trying to locate a company where I can buy the weekly closing prices of the New York Stock Exchange and the Commodity exchanges on audio cassette.

I hope one of your readers can help me. Thank you.

Earl O Williams
280 Henderson St Apt 7J
Jersey City NJ 07302■

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- 80 or 120 columns (software selectable)
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A large Japanese hardware manufacturer recently introduced a good, low cost print mechanism into the U.S. market. They also announced a fully packaged printer using this mechanism to the OEM market. Then another company started to sell this printer to hobby, home and small business computer users.

We took a long hard look at this printer and liked what we saw. The mechanism was reliable. The case was beautifully designed. What we didn't care for was the 5 x 7 dot matrix format. We also believed some form of condensed character set and a few other alterations in software would be significant improvements.

So we bought the mechanism and the case. But we designed our own logic board and wrote new software. The Microtek Printer. Looks the same as the others but really isn't. It's better. It's one giant step ahead of its competition.


CHECK THIS CHART...

FEATURES	**Microtek MT-80**	Anadex DP-8000	Centronics 779-2 (Radio Shack 26-1152)	Centronics 730-1 (Radio Shack 26-1154)	Super Brain LP-80
Dot matrix format	**9x7**	9x7	5x7	7x7	5x7
Characters per line	**80/120**	80	80/132	80	80
96 char ASCII (upper + lower case)	**Yes**	Yes	No	Yes	Yes
Throughput rate	**70 lpm**	84 lpm	21 lpm	21 lpm	63 lpm
VFU	**Standard**	Standard	N/A	N/A	Standard
Bi-directional printing?	**Yes**	Yes	No	No	Yes
Built-in self test?	**Yes**	No	No	No	Yes
Unit price	**$750***	$995	$1,350-1,559	$970-995	$985

*Parallel interface

Comparison data from manufacturer's current (August '79) literature.

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Morrow Designs
Thinker Toys™

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Tracing Your Own Roots

Stan W Merrill
Computer Resource Associates
914 E 61st St
Chicago IL 60637

Tracing your own roots satisfies an intangible craving that many people have — a craving to understand your place in a heritage that was developed by people who are perhaps more like yourself (at least genetically) than any other people on Earth. The process involves untangling puzzles that tax the most intelligent imagination. Relationships must be deciphered from other people's memories and from bits and pieces of written records that form a fragile and sometimes inadequate link between you and your ancestors. It is a natural application for a microcomputer.

Doing Genealogy

How does a person go about tracing his or her roots? There are several steps that make the process simpler. Some of these steps are enumerated in the following section.

Step 1. The best place to start searching for your family is, of course, at home. You should jot down on paper or key into the computer all the things that you know (or think you know) about your ancestry, then look for family records, such as Bibles and correspondence. Frequently these will contain useful leads that make it easier to document facts later on. Next, contact family members: parents, siblings, the proverbial great-great-aunt, and anyone else who might possess a piece of family information. It is useful to quiz these relatives about parents, events, dates, and places, beginning with those people who are closest to you in time, and working backward.

If other family members are interested, it may be possible to establish a family organization that will hold occasional family reunions and share the fun and work of searching out ancestors. Such an organization already exists in many families.

It is not unusual for such contact with family members to plunge the new genealogist into the first meaningful contacts with some relatives. Such contact draws people into warmer and closer relationship that is, in itself, a substantial reward for the effort invested in genealogy.

Step 2. The memories collected from family members cannot usually provide adequate proof of the events recalled, since the human capacity to remember information accurately is imperfect. Memories merely provide hints for where to look for birth, marriage, and death certificates (known as *vital records*), or for entries in church and civil record books that will document the information. These documents provide official information about particular ancestors, and also give possible clues about other ancestors in the chain.

Several sources exist for finding these documents. Often ancestors will have resided in a single locality for several generations. A letter to the clerk of the political jurisdiction (county, province, etc) where they lived, or to the parish cleric in countries where churches kept the vital records, will often elicit copies of desirable information. These places can be visited in person as well.

A number of institutions collect and preserve genealogical records on a national or international basis, and make these records available to the public. The institution with what is undoubtedly the most complete collection is:

The Genealogical Society
Church of Jesus Christ
of Latter Day Saints
50 E North Temple
Salt Lake City UT 84102

You do not have to belong to the Church of Latter Day Saints in order to use their genealogical data sources. While the main library is in Utah, branch libraries are scattered throughout the United States and much of the world. The telephone number of a unit of the church can be found in most telephone directories, and a phone call will produce information about the location of the nearest branch library.

Other excellent sources of genealogical data include:

About the Author

Stan W Merrill is a partner in Computer Resource Associates, a Chicago based consulting firm which he recently helped found. Between times, he is writing his doctoral dissertation in sociology at the University of Chicago. Genealogy is a traditional activity in his family, and some of his lines have been traced back several centuries.

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Bill Birkett, Vice President,
Trade Graphics, Inc.,
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To find out where you can find Scotch Data Cartridges or virtually any other data recording medium, call toll-free: 800-328-1300. (In Minnesota, call collect: 612-736-9625.) Ask for the Data Recording Products Division.

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Circle 368 on inquiry card.

Central Reference Div
National Archives
Washington DC 20408

Library of Congress
Washington DC 20540

Newberry Library
60 W Walton St
Chicago IL 60610

New York Public Library
5th Av and 42nd St
New York NY 10018

This list is not exhaustive, but writing or visiting one of these places will help anybody get started. It is also useful to talk to a reference librarian at a local library. They will often know of nearby sources of genealogical information.

Step 3. It is fairly easy and pleasant for most people to trace back their ancestry 3 or 4 generations. But when a line migrates across an ocean, or when records become less complete (as they invariably do when going further back in time), ingenuity comes into play. Passenger lists, censuses, and tax lists may provide clues to the identity of ancestors who cannot be located in vital records. A knowledge of history is acquired while searching for clues about mass movements in which ancestors may have participated.

This is where the computer comes in. To know what is missing becomes increasingly difficult as the number of ancestors for whom you have information increases. It scarcely needs to be said that computerizing the records makes it much simpler to keep track of the data.

Still more helpful is the use of the computer to solve puzzles. Suppose, for instance, that you cannot find any more family members in a certain line, but you notice from the output data that a related family line has moved to a new locality at about the same time. You have been given a hint that the first family line may also have migrated there, and you can begin to search for information in the records of that particular place.

Using the Program

You need not be a genealogical expert to utilize the program that is listed here. Item 1 on the program's menu (table 1) automatically prompts the user for the most important information about each ancestor. (See listing 1.) This information includes birth date and place, parentage, marriages, and date and place of death. The program asks for the sources of information too, so that the inevitable need to check entries will be easier.

To list the information for any or all of the names that have been entered into the file, you can use item 2 on the menu. An example of a listing for one individual is shown in listing 2. A person can be located by name or by number. Because it is possible for there to be more than one individual in the file with the same name, you should make certain that the person listed is the correct one. The program as now written will not search beyond the first occurrence of a name unless the *all* option is selected. When all is typed in response to the prompt, the subroutine will read sequentially through all of the records in the file.

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*Apple II is a registered trademark of Apple Computers, Inc.





California Computer Systems
309 Laurelwood Road, Santa Clara, CA 95050, (408) 988-1620

So Nobody Goes Away Mad.

Circle 38 on inquiry card

In addition to listing file entries, menu item 2 will revise entries. If a revision is made because new information has been found, simply enter the number (or name) of the person for whom the revisions are to be made, and then select the type of information that is to be updated. The revision subroutines are *document oriented*, that is, each asks for all of the information that is commonly found on a particular vital record. For example, the marriage revision subroutine requests the date of marriage, the spouse's name, the place where the marriage was performed, and the source from which the information was obtained, because all of these items are found on a marriage certificate. The document orientation of the revision routines suits the genealogist's situation well, for the need to update information about an ancestor will usually arise from the discovery of a new document.

If you wish to revise an error that was made while entering information the first time, you should first finish entering all of the information requested by the program. The computer will then prompt for changes by going back to the original menu.

Item 2 will also generate blank data-collection forms which can be used for gathering information to enter into the computer. This is done by putting a special symbol in the data fields for every relevant name,

```
PLEASE ENTER THE NUMBER OF THE
PROCEDURE YOU WANT:
 (1) ENTER INFORMATION
 (2) READ OR REVISE INFORMATION
 (3) LIST PEDIGREE
 (4) END THE PROGRAM
?
```

Table 1: The genealogy program prompts the user for a specific use. The user can enter and modify information, list a person's pedigree for 4 generations, or finish the program use.

```
TASK: ADD GENEALOGICAL INFORMATION TO THE FILE

WHAT IS THE PERSON'S NAME?
(USE MAIDEN NAME WHERE APPROPRIATE)
 ? THOMAS MERRILL


TO PREVENT THOMAS MERRILL
FROM BEING CONFUSED WITH SOMEONE ELSE
WHO MAY HAVE A SIMILAR NAME, HE/SHE
SHOULD HAVE A UNIQUE NUMBER IN THIS FILE.

HAS A NUMBER ALREADY BEEN ASSIGNED?
 ? YES

PLEASE ENTER THE NUMBER:
 ? 14

I WILL ASK YOU FOR SOME DATES.
PLEASE ENTER DATES IN THE FOLLOWING
FORMAT:  DAY   MONTH   YEAR
   EXAMPLE: 23 APRIL 1949
IF YOU DON'T KNOW A DATE, ENTER 'UNKNOWN'.


WHEN WAS THOMAS MERRILL            BORN (DA MO YR)?
 ? 20 NOVEMBER 1715

WHERE WAS HE/SHE BORN?
 ? HARTFORD CONNECTICUT


WHAT WAS THOMAS MERRILL           'S FATHER'S NAME?
(IF YOU DON'T KNOW, ENTER 'UNKNOWN')
 ? ABEL MERRILL


DOES ABEL MERRILL                ALREADY HAVE A NUMBER?
 ? Y

PLEASE ENTER HIS NUMBER:
 ? 15

WHAT WAS THOMAS MERRILL           'S MOTHER'S NAME?
(USE MAIDEN NAME IF POSSIBLE.  IF YOU
DON'T KNOW HER NAME, ENTER 'UNKNOWN')
 ? MEHITABLE EASTON
```

```
DOES SHE ALREADY HAVE A NUMBER?
 ? Y

PLEASE ENTER HER NUMBER:
 ? 16


WHERE DID YOU GET THE INFORMATION ABOUT
THOMAS MERRILL            'S BIRTH AND PARENTAGE?
(BE SPECIFIC)
 ? BIRTH CERTIFICATE 13347A


HOW MANY TIMES WAS THOMAS MERRILL            MARRIED?
(ENTER A DIGIT FROM 0 TO 99)
 ? 1


ENTER A DATE FOR MARRIAGE # 1   (DA MO YR)
 ? 5 OCTOBER 1755


WHAT WAS THE SPOUSE'S FULL NAME?
(USE MAIDEN NAME WHERE APPLICABLE)
 ? MARTHA WOOD


WHERE WERE THEY MARRIED?
 ? HARTFORD CONNECTICUT


WHERE DID YOU GET THE INFORMATION ABOUT MARRIAGE # 1 ?
 ? MARRIAGE CERTIFICATE 3445 B


WHEN DID THOMAS MERRILL            DIE (DA MO YR)?
(IF YOU DON'T KNOW, ENTER 'UNKNOWN'.
IF HE OR SHE IS STILL LIVING, ENTER 'ALIVE'.)
 ? 16 JUNE 1814


WHERE DID HE/SHE DIE?
 ? HARTFORD CONNECTICUT


WHERE DID YOU GET THE INFORMATION ABOUT HIS/HER DEATH?
 ? DEATH CERTIFICATE 3988 C
```

Listing 1: When adding information to the file, the program prompts you for every input and describes the form that it should take. If an error is made during input, the rest of the information should be completed and the revise *option chosen from the main menu upon completion.*

MOVING DATA AT A SNAIL'S PACE BECAUSE YOU'RE FLOPPY BOUND?

Let Corvus Systems put you back in the race!



CORVUS SYSTEMS, Inc.

900 S. Winchester Boulevard
San Jose, California 95128
408/246-0461

Circle 83 on inquiry card.

```
TASK: READ AND REVISE FILE INFORMATION


DO YOU WISH TO SEARCH BY 'NAME' OR BY 'NUMBER'?
 ? NUMBER

PLEASE ENTER THE NUMBER:
 ? 14


GENEALOGICAL INFORMATION FOR:
THOMAS MERRILL
NUMBER: 14

BORN: 20 NOVEMBER 1715
BIRTHPLACE: HARTFORD CONNECTICUT

FATHER: ABEL MERRILL                    (NUMBER: 15 )
MOTHER: MEHITABLE EASTON                (NUMBER: 16 )

MARRIED TO:
  MARTHA WOOD
      DATE: 5 OCTOBER 1755
      PLACE: HARTFORD CONNECTICUT

DEATH DATE: 16 JUNE 1814
PLACE OF DEATH: HARTFORD CONNECTICUT


RECORDS SOURCE:
   BIRTH AND PARENTAGE: BIRTH CERTIFICATE 13347A
   MARRIAGE # 1 :MARRIAGE CERTIFICATE 3445 B
   DEATH: DEATH CERTIFICATE 3988 C


DO YOU WISH TO CHANGE ANYTHING?
 ? NO


WOULD YOU CARE TO EXAMINE ANOTHER RECORD?
 ? YES
```

Listing 2: A file may be found and read by either name or number. When the data has been reviewed, the user may update the file using the revision command.

```
TASK: LIST PEDIGREE


WHOSE PEDIGREE WOULD YOU LIKE PRINTED?
(ENTER HIS/HER NUMBER, PLEASE)
 ? 14


THE SYMBOL 'F' STANDS FOR 'FATHER'
THE SYMBOL 'M' STANDS FOR 'MOTHER'


               PEDIGREE FOR PERSON # 14

THOMAS MERRILL

     F:ABEL MERRILL              (NUMBER: 15 )
     M:MEHITABLE EASTON          (NUMBER: 16 )

          FF:JOHN MERRILL              (NUMBER: 17 )
          FM:SARAH WATSON              (NUMBER: 18 )

          MF:JOHN EASTON               (NUMBER: 19 )
          MM:ELIZABETH (EASTON)        (NUMBER: 20 )

               FFF:NATHANIEL MERRILL         (NUMBER: 21 )
               FFM:SUSANNAH WOLTERTON        (NUMBER: 22 )

               FMF:JOHN WATSON               (NUMBER: 25 )
               FMM:MARGARET SMITH            (NUMBER: 26 )

               MFF:JOSEPH EASTON             (NUMBER: 27 )
               MFM:HANNAH (EASTON)           (NUMBER: 28 )

               MMF:UNKNOWN                   (NUMBER: 0 )
               MMM:UNKNOWN                   (NUMBER: 0 )
```

Listing 3: When a pedigree is requested, a person's ancestry is traced back 4 generations. If the ancestry is unknown, then this is stated.

place, date, and source in item 1. (A question mark (?) makes a good symbol for this purpose. The number 0 can be used when the computer prompts for a number for the individual and his parents. The number 1 is a good response when the computer asks how many times the individual was married.) Either the special symbol or the number assigned by the program to the special form is then used in item 2. The number or symbol can be requested repeatedly to obtain as many copies of the form as are desired.

The program assigns a unique number to each ancestor so that it can differentiate between people with the same name. (My own genealogy contains cases where as many as 3 individuals have identical names.) Utilizing these numbers, the program will link up any person in the file with 4 generations of his or her ancestors, thus forming a *pedigree chart*. An example of such a pedigree is shown in listing 3. It is not necessary that everyone in the file be related. The program can tell who is related to whom on the basis of the number assigned to each person.

Other Ideas

The genealogy program in listing 4 prompts you to enter important identifying information about your ancestors. It will print back this information and allow revisions. It will also print a 4 generation pedigree for any person in the file, but its usefulness need not stop there: your own imagination can provide personal additions. You might wish to expand the pedigree section to print out more generations, or write a subroutine which will sort persons of the file into nuclear family groups. You might choose to add a subroutine to calculate age of death for each ancestor and average age of death for subgroups of ancestors. This could provide insight into the impact of historical conditions on longevity in your family, and could even be applied toward figuring out your own life expectancy. Along these same lines, you could add a prompt for cause of death — an item usually found on a death certificate. Inspection of the cause of death for a large number of ancestors might even alert you to special diseases that occur regularly in your family.

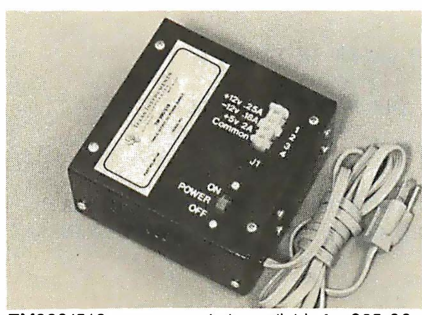
9900

New easy-to-use educational module. Your best ticket to the microprocessor world. Ideal for teaching. Yourself. Or others.

TI's new TM990/189 University Module is a stand-alone learning lab. Fully assembled and designed for maximum hands-on experience. To ease and simplify learning and teaching.

Outstanding features include powerful 16-bit microprocessor with easy-to-learn, easy-to-use minicomputer instruction set; 45-key alphanumeric keyboard and ten-digit seven-segment display for easy **assembly-language** programming; ROM-resident software including system monitor for program debug and symbolic assembler; audio cassette interface; easy-to-add EIA and TTY interface; 1K-byte RAM expandable to 2K; 4K-byte ROM and 2K-byte expansion EPROM socket; 16-bit programmable I/O controller; user addressable LEDs, and sound indicator.

A 570-page tutorial text accompanies the module. It is a detailed guide for self-paced learning. Or the basis for a three-hour university course. Chapters include an overview of microprocessors; programming exercises; assembly language; memory systems; I/O concepts and designs; software engineering; product development; a variety of lab experiments, and much more. Also with the module: a 300-page user's guide.



TM990/519 power supply is available for $65.00.

The University Module complete with tutorial text and user's guide is only $299.00.

Order **your University Module** from your authorized TI distributor. For more information, write Texas Instruments Incorporated, P.O. Box 1443, M/S 6404, Houston, Texas 77001.

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Circle 372 on inquiry card.

TEXAS INSTRUMENTS
INCORPORATED

85577

Listing 4: The genealogical program source listing in BASIC Plus 2. Only the input and output statements will need to be changed to adapt this program to most microcomputers with disk storage.

```
00010 PRINT TAB(19);'GENEALOGICAL PROGRAM'
00020 !
00030 !   WRITTEN BY STAN W. MERRILL
00040 !           OF COMPUTER RESOURCE ASSOCIATES
00050 !              914 EAST SIXTY-FIRST STREET
00060 !              CHICAGO, ILLINOIS 60637
00070 !              (312) 363-6183
00080 !
00090 !      ALLOCATE FILE AND COUNT NUMBER OF CASES ALREADY IN IT
00100 !      SET COUNTERS
00110 !
00120 PRINT\PRINT\PRINT
00130 ON ERROR GO TO 350
00140 MAP GENDATA B,C$(3)=16,D$=25,E$=16,F,G$(3)=25,H$=20,J$=16,K$(3)=20
,L$=20,Q$=25,S$=25,R,T,D1$=40,D2$(3)=40,D3$=40
00150 OPEN 'GEN' AS FILE #1, SEQUENTIAL VARIABLE, MAP GENDATA, INVALID
130
00160 LET I2=0
00170 LET I3=0    ! I3 COUNTS NUMBER OF CASES IN FILE
00180 !
00190 PRINT "WOULD YOU LIKE A LIST OF THE NAMES CURRENTLY"
00200 PRINT "IN THE FILE?"
00210 INPUT W1$
00220 PRINT
00230 IF W1$='Y' THEN PRINT "THE FILE CONTAINS THE FOLLOWING NAMES:"
00240 IF W1$='YES' THEN PRINT "THE FILE CONTAINS THE FOLLOWING NAMES:"
00250 PRINT
00260 GET #1
00270 LET I3=I3+1
00280 IF W1$='Y' THEN PRINT D$,B
00290 IF W1$='YES' THEN PRINT D$,B
```

Listing 4 continued on next page

This genealogy program was written on a DECsystem 2050 at the University of Chicago, using DEC's BASIC Plus 2. The file I/O (input/output) under BASIC Plus 2 differs from that in many other BASICs and may require some revision when running the program under another interpreter or compiler. For instance, the MAP statement, which BASIC Plus 2 uses to allocate space for variables, is unnecessary in some versions of BASIC.

To make the program smaller, reduce the number of prompts. Another possibility is to break the program into smaller programs, each of which can be loaded into memory independently as needed. The 3 major subroutines (labeled "procedure subroutines" in listing 4) are almost self-sufficient, that is, they can be entered as separate programs with only slight modification. However, procedure subroutine 2 calls several revision subroutines *(lines 4170 thru 4850) which should be included with it, if it is made into a separate program.*

Another use for the information in the file is for studying naming traditions. Do certain names appear over and over in the family? Are surnames commonly used for given or middle names? Perhaps the file contains ideas for naming your own children (pets, etc). Studying names can help in the understanding of implicit family values and the transfer of power and prestige in the family.

You may wish to add a subroutine for collecting biographical anecdotes about ancestors. This is a real programming challenge, given the limited string handling capabilities of most versions of BASIC.

Conclusion

Genealogy matches you and your computer against exciting and worthwhile puzzles that challenge the best abilities of both man and machine. Its rewards include a closer relationship with your family, increased knowledge of history gleaned from a search for facts that may have affected ancestral migration and marriage patterns, and a self-knowledge derived from examination of people like yourself.

Listing 4 continued:

```
00300 !
00310 IF B>I2 THEN LET I2=B
00320 IF R>I2 THEN LET I2=R
00330 IF T>I2 THEN LET I2=T
00340 GO TO 260
00350 RESUME 390
00360 !
00370 !        MENU OF PROCEDURES
00380 !
00390 PRINT\PRINT\PRINT
00400 PRINT 'PLEASE ENTER THE NUMBER OF THE PROCEDURE'
00410 PRINT 'YOU WANT:'
00420 PRINT
00430 PRINT TAB(10);'(1) ENTER INFORMATION'
00440 PRINT TAB(10);'(2) READ OR REVISE INFORMATION'
00450 PRINT TAB(10);'(3) LIST PEDIGREE'
00460 PRINT TAB(10);'(4) END THE PROGRAM'
00470 INPUT A
00480 IF A=1 THEN GOSUB 570      !ENTER INFORMATION
00490 IF A=2 THEN GOSUB 2000     !READ THE INFORMATION
00500 IF A=3 THEN GOSUB 3090     !LIST PEDIGREE
00510 IF A=4 THEN GO TO 4900     ! END PROGRAM
00520 GO TO 390                  !INPUT ERROR—TRY AGAIN
00530 !
00540 !        PROCEDURE SUBROUTINE #1
00550 !           BIRTH CERTIFICATE INFORMATION
00560 !
00570 PRINT\PRINT
00580 PRINT 'TASK: ADD GENEALOGICAL INFORMATION TO THE FILE'
00590 OPEN 'GEN' FOR INPUT AS FILE #1, SEQUENTIAL VARIABLE, ACCESS
APPEND, MAP GENDATA, INVALID 130
00600 PRINT\PRINT
00610 PRINT "WHAT IS THE PERSON'S NAME?"
```

Listing 4 continued on page 32

Listing 4 continued:

```
00620 PRINT "(USE MAIDEN NAME WHERE APPROPRIATE)"
00630 INPUT D$
00640 PRINT\PRINT
00650 PRINT "TO PREVENT ";D$
00660 PRINT "FROM BEING CONFUSED WITH SOMEONE ELSE"
00670 PRINT "WHO MAY HAVE A SIMILAR NAME, HE/SHE"
00680 PRINT "SHOULD HAVE A UNIQUE NUMBER IN THIS FILE."
00690 PRINT
00700 PRINT "HAS A NUMBER ALREADY BEEN ASSIGNED?"
00710 INPUT V$
00720 IF V$='Y' THEN 820
00730 IF V$='YES' THEN 820
00740 IF V$<>'N' THEN IF V$<>'NO' THEN GO TO 690
00750 LET I2=I2+1
00760 LET B=I2
00770 PRINT
00780 PRINT "HE/SHE HAS BEEN ASSIGNED THE NUMBER:"
00790 PRINT
00800 PRINT TAB(10);B
00810 GO TO 850
00820 PRINT
00830 PRINT "PLEASE ENTER THE NUMBER:"
00840 INPUT B
00850 PRINT\PRINT
00860 PRINT "I WILL ASK YOU FOR SOME DATES."
00870 PRINT "PLEASE ENTER DATES IN THE FOLLOWING"
00880 PRINT "FORMAT:  DAY   MONTH   YEAR"
00890 PRINT "   EXAMPLE: 23 APRIL 1949"
00900 PRINT "IF YOU DON'T KNOW A DATE, ENTER 'UNKNOWN'."
00910 PRINT\PRINT
00920 PRINT 'WHEN WAS ';D$;' BORN (DA MO YR)?'
00930 INPUT E$
00940 PRINT
00950 PRINT "WHERE WAS HE/SHE BORN?"
00960 INPUT H$
00970 PRINT\PRINT
00980 PRINT "WHAT WAS ";D$;"'S FATHER'S NAME?"
00990 PRINT "(IF YOU DON'T KNOW, ENTER 'UNKNOWN')"
01000 INPUT Q$
01010 IF Q$='UNKNOWN' THEN GO TO 1200
01020 PRINT\PRINT
01030 PRINT "DOES ";Q$;" ALREADY HAVE A NUMBER?"
01040 INPUT V$
01050 IF V$='Y' THEN 1160
01060 IF V$='YES' THEN 1160
01070 IF V$<>'N' THEN IF V$<>'NO' THEN GO TO 1020
01080 PRINT
01090 LET I2=I2+1
01100 LET R=I2
01110 PRINT "HE HAS BEEN ASSIGNED THE NUMBER:"
01120 PRINT
01130 PRINT TAB(10);R
01140 PRINT\PRINT
01150 GO TO 1220
01160 PRINT
01170 PRINT "PLEASE ENTER HIS NUMBER:"
01180 INPUT R
01190 GO TO 1220
01200 LET R=0
01210 PRINT\PRINT
01220 PRINT "WHAT WAS ";D$;"'S MOTHER'S NAME?"
01230 PRINT "(USE MAIDEN NAME IF POSSIBLE.  IF YOU"
01240 PRINT "DON'T KNOW HER NAME, ENTER 'UNKNOWN')"
01250 INPUT S$
01260 IF S$='UNKNOWN' THEN GO TO 1430
01270 PRINT\PRINT
01280 PRINT "DOES SHE ALREADY HAVE A NUMBER?"
01290 INPUT V$
01300 IF V$='Y' THEN GO TO 1400
01310 IF V$='YES' THEN GO TO 1400
01320 IF V$<>'N' THEN IF V$<>'NO' THEN GO TO 1270
```

Listing 4 continued on page 42



OHIO SCIENTIFIC

YOUR NEXT COMPUTER

You know about computers. In fact, you probably own one now. One that you might be thinking of expanding. We have a better idea. Take a really giant step into the personal computing future with a C4P or C8P from Ohio Scientific. These two new premium computer systems offer the best specs in the personal computing industry with built-in performance levels that you could never achieve with your present system, even with all the add-ons available. We'll show you why.

THE FACTS

SPEED

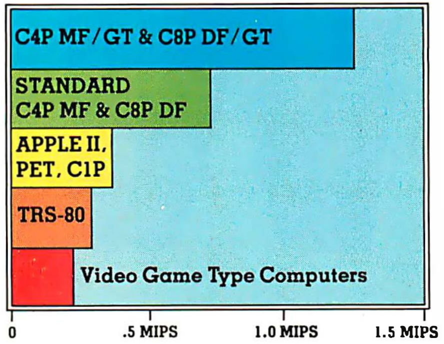
Speed separates the computers from the toys. The faster the processor executes instructions the more elaborate and greater the I/O can be. The C4P and C8P have execution speed that is twice as fast as Apple II, or Commodore PET and over THREE times as fast as TRS-80. They are many times faster than the recently introduced flock of video game type computers.

GT OPTION As if that weren't fast enough, the C4P and C8P's speed is nearly doubled when equipped with the Ohio Scientific GT option. By utilizing a 6502C microprocessor in conjunction with ultra-fast static memories, a C4P or C8P equipped with the GT option, will yield the following performance:

1.2 million instructions per second. Average.

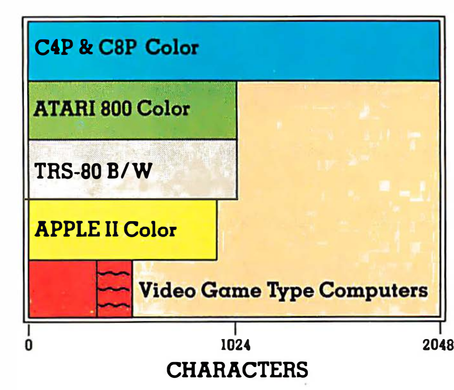
Memory to accumulator ADD time — 600NS.

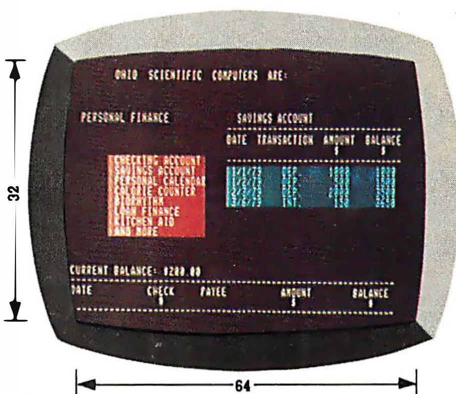
JUMP extended — 900NS.

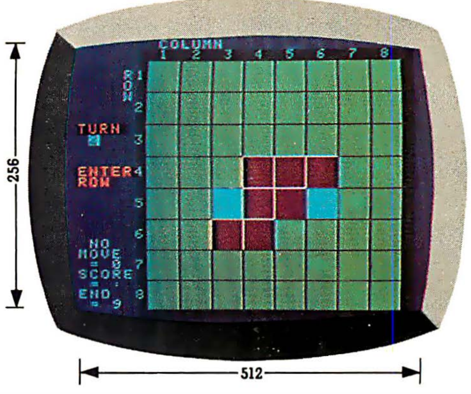


DISPLAY

The C4P and the C8P offer more display than other personal computers — 2048 characters — 32 rows of 64 columns with upper and lower case. Long display width makes user instruction easier to program and to read. The effective graphics resolution of 256 x 512 points allows these computers to match the display limit of even the best color television sets.

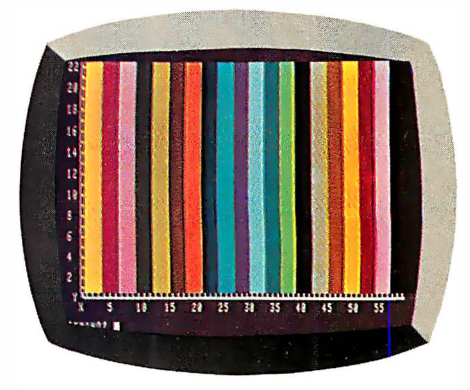






16 COLORS

The C4P and C8P offer a brilliant array of 16 colors including black available in both alphabetics and graphics.



CONSTRUCTION

The C4P incorporates a fully RF shielded aluminum case with 2-step baked on enamel finish. It is trimmed with solid oiled walnut and die-cast chromed dress panels. Compare its construction to the plastic cases that are standard on other personal computers.

The quality doesn't stop at the surface. The C4P and C8P are modular BUS orientated computers with 4 and 8 slots respectively. The internal electronics are built to rigorous industrial standards.

Modularity means expandability and obsolescence protection. In fact, the original 1977 vintage C2-4P can be upgraded to a C4P by changing PC cards at substantially less cost than purchasing a new computer.

* Apple II, Commodore PET, TRS-80, and Atari 800 are registered trade names of Apple Computer Inc., Commodore Business Machines Ltd., Radio Shack, Atari, respectively.

Circle 300 on inquiry card.

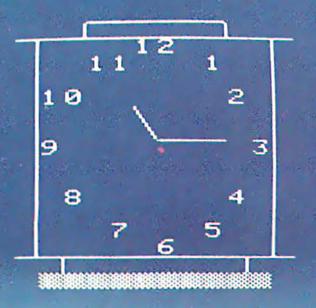


The C4P MF is shown with optional accessories (clockwise). Home Color TV set (requires RF modulator), 2 joy sticks, AC-Remote console and 2 modules, wireless smoke detector and window detector, modem, printer and wireless remote security console (on top of TV.)

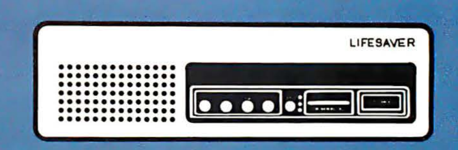
JUST LOOK AT ALL THE I/O OF THE C4P MF — BUILT IN

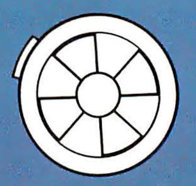
INTERFACES

I/O capabilities. The most important feature to look for when you purchase your next computer. Compare these standard features of the C4P and C8P disk systems to any other computer system. Regardless of price, you'll find none that even come close.

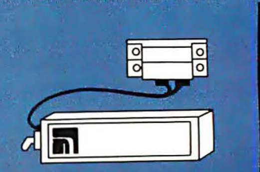


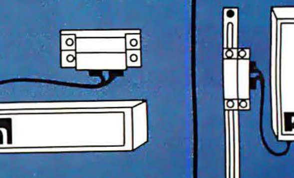
CLOCK
1-Real time clock and count down timer



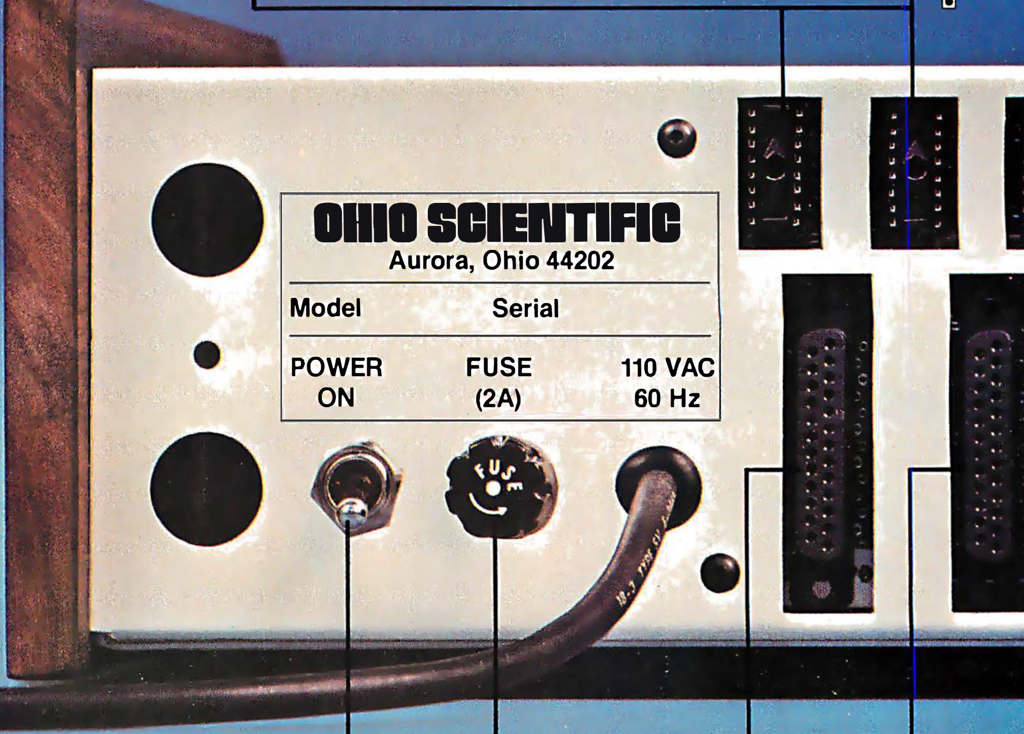


HOME SECURITY INTERFACES
1-home security interface with fire and intrusion detection





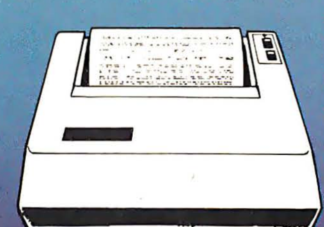
CONTROL INTERFACES
16 parallel I/O lines



ON/OFF Switch

Fuse

RS — 232 PORTS
1-300 baud modem port
1-300/1200 baud printer port
Directly connect to an optional modem and printer



Only an Ohio Scientific C4P MF or C8P DF can offer you all this I/O.

Circle 300 on inquiry card.

AVAILABLE ON THE BACK AND READY TO RUN.

ACCESSORY BUS
One accessory BUS connector for an external 48 line I/O board, PROM blaster, analog data module or education board.

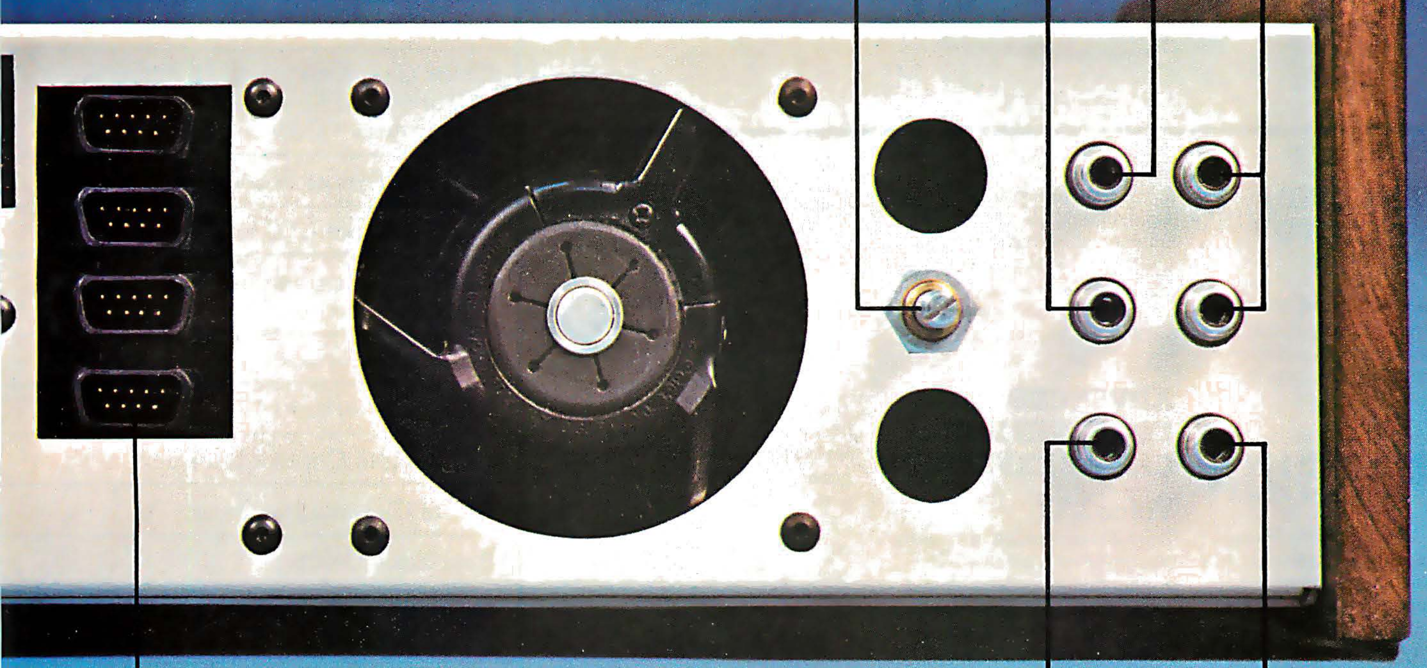


SOUND
1-programmable tone generator 200 — 20KHz
1-8 bit companding digital to analog converter (DAC) for music and voice output

Cassette IN
(Cassette Versions Only)

Color Adj.

Video Display



Cassette OUT
(Cassette Versions Only)

HUMAN INPUT EXPANSION
2-8 axis joystick interfaces
2-10 keypad interfaces

HOME INTERFACES
1—AC-12 AC remote control interface





SOFTWARE

Ohio Scientific offers a full comprehensive library of both systems and applications software for the C4P and the C8P. And, because our main language is Microsoft BASIC like most other personal computers, much of your old software can be used on the C4P and C8P with little or no modification except for the special I/O functions and the much faster speed of your new computer. This would include software from the TRS-80 Level II, Apple floating point BASIC, Commodore BASIC and many others.

SYSTEMS INTEGRATION

There is a lot of software available for a lot of computers. Unfortunately for the user in almost every case the computer is available from one supplier, software is available from a dozen independent suppliers and accessory devices are available from yet other suppliers. Ohio Scientific has a different approach. We offer a comprehensive library of systems and applications software for the 4P and 8P. In fact, we offer more factory supported software than any other personal computer company. For example, say you have a brand X computer and you buy a real time clock from company Y which supplies software to use the clock. Then you buy an AC controller from company Z who also provides software. The system works fine as long as you want to monitor time or control AC devices but you are out of luck when you want to use the clock in conjunction with controlling AC devices. With Ohio Scientific's systems you can be monitoring home security, time, controlling AC devices and be playing an exciting video game, all at the same time because the systems software, the applications software, and the accessories *form an integrated package which works together without end user modification.*



FOREGROUND/ BACKGROUND OPERATION

This means that your computer can be engaging in home monitoring activities at the same time it is running other programs.

EXPANSION

As you can see, the C4P and C8P are truly exceptional premium computers with just their standard features alone. Above and beyond that they are easily expandable to add exciting advanced features like word processing, additional memory, voice I/O, and our new universal telephone interface (UTI).

C4P VS. C8P

The C4P is a 4-slot portable computer with one open slot for expansion. The C8P is an 8-slot mainframe class computer with five open slots. It features over 3 times the expansion capability of the C4P for advanced home, experimental and small business applications. The C8P's dual 8" floppies store about 8 times the information of a single mini-floppy and access it many times faster.

ADVANCED FEATURES FOR C8P DF EXPANSION

Voice I/O

The C8P DF can be optionally equipped with a voice I/O system that includes a Votrax module capable of generating English speech phonetically. It also has provisions for a user populated 5-channel feature extractor for voice input experimentation.

Universal Telephone Interface (UTI)

Optionally equipped with a Universal Telephone Interface system, the C8P DF has the ability to dial any telephone number, utilizing rotary dial or touch tone telephone lines. It can respond to touch tone or modem signals and can route voice to tape recorders.

It can answer by touch tone, modem, stored message or Votrax voice output (when equipped with Votrax module or used in conjunction with a CA-14 Voice I/O.)

A C8P DF with UTI, voice output, AC-Remote, home security and its clock yield the home computer of the future with uncannily human-like capabilities to communicate via phone lines and operate and monitor typical home functions.

FINAL FACTS

Buying a new computer is a serious, long-term investment. So we invite you to shop around and compare. The closest thing you'll find to a C4P or C8P will cost twice as much and offer less than half the performance. We know. Because there's nothing like these exceptional premium computers at any price, anywhere. And probably won't be for a very long time.

*TRS-80 Level II, Apple floating point BASIC and Commodore BASIC are registered trade names of, Radio Shack, Apple Computer Inc., Commodore Business Machines Ltd., respectively.

SPECIFICATION CHART

FEATURE
Microprocessor type GT option 6502C
Full 53-key Keyboard
BASIC in ROM
BASIC on Disk
Minimal Config. RAM
Minimal Config. Total Memory RAM + Display + ROM
Maximum RAM
TV/Video Monitor
Cassette Recorder
Mini-Floppy Disk
Dual Mini-Floppy Disk
Dual 8" Floppy Disk
Video Display
Color Graphics (up to 16 colors), Upper and Lower Case, Graphics + Gaming Elements
Effective Screen Resolution
Audio Output (200 to 20KHz)
DAC for Voice and Music Generation
Key Pad Interfaces
Joystick Interfaces
AC Remote Control Interface
Audio Cassette Interface
Real Time Clock
Home Security System Interface
Printer Interface
Modem Interface
16 Parallel Lines + Acc'y. BUS
GT Option
Winchester Hard Disks Option
Voice I/O
Telephone Interface

	C4P	C4P MF	C8P	C8P DF
	6502	6502A	6502	6502A
	Yes	Yes	Yes	Yes
	Yes	No	Yes	No
	No	Yes	No	Yes
	8K	24K	8K	32K
	19.5K	27.5K	19.5K	35.5K
	32K	48K	32K	48K
	Acc'y.	Acc'y.	Acc'y.	Acc'y.
	Acc'y.	No	Acc'y.	No
	Acc'y.	Yes	No	No
	Acc'y.	Acc'y.	No	No
	No	No	Acc'y.	Yes
	32 x 64	32 x 64	32 x 64	32 x 64
	Yes	Yes	Yes	Yes
	256 x 512	256 x 512	256 x 512	256 x 512
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	No	Yes	No
	No	Yes	No	Yes
	No	Yes	No	Yes
	Yes*	Yes	Yes*	Yes
	No	Yes	No	Yes
	No	Yes	No	Yes
	No	Acc'y.	No	Acc'y.
	No	No	Acc'y.	Acc'y.
	No	No	Acc'y.	Acc'y.
	No	No	Acc'y.	Acc'y.

*Not wired to connector.



Computers come with keyboards and floppies where specified. Other equipment shown is optional.

HARDWARE

COMPUTERS

Model	Description	Price
C4P	8K BASIC in ROM, 8K RAM, Demo Cassette	$ 698
C4P MF	24K RAM, Single Mini-Floppy, OS-65D 3.1 operating system and 2 demo disks	1,695
C8P	8K BASIC in ROM, 8K RAM, Demo Cassette	895
C8PDF	32K RAM Dual 8" floppies, OS-65D 3.1 and 2 demo disks.	2,597

ACCESSORIES

C4P	C4P MF	C8P	C8PDF	Model	Description	Price
●	●	●	●	AC-3P	12" B/W Combination Monitor/TV	$ 115
●	●	●	●	AC-15P	12" Color Monitor	399
●	●	●	●	AC-16P	2—8 Axis Joy sticks with cables	39
	●		●	AC-11P	Answer/Originate 300 baud modem with cable	199
●	●	●	●	AC-12P	AC-Remote starter set, console, 2 lamp modules, 2 appliance modules, OS-65D home control operating system.	175
	●		●	AC-17P	Home security starter set (wireless), console, 1 fire detector 2-window units, one door unit and Demonstration software.	249
		●	●	CA-15	Universal telephone interface with touch tone encoder / decoder, 300 baud orginate / answer modem, analog signal mux / demux.	499
		●	●	CA-15V	As above with Votrax voice module for computer generated voice response.	799

PRINTERS

C4P	C4P MF	C8P	C8PDF	Model	Description	Price
●	●	●	●	AC-18P	Low cost high speed 8½" aluminized paper printer with upper/lower case.	$ 695
		●	●	AC-9TP	Centronics 779 110 cps tractor feed Business printer with interface.	1,250
	●	●	●	AC-14	NEC Spinwriter—word processing printer with high speed parallel Interface.	2,795

GT OPTIONS (must be purchased with computer)

C4P	C4P MF	C8P	C8PDF	Model	Description	Price
	●			C4P MF/GT	24K, 120NS Memory, 6502C processor, 2-speed clock.	add $ 950
			●	C8P DF/GT	48K, 120NS Memory, 6502C processor, 2 speed clock.	add 1,825

For other expansion accessories such as add-on memory, additional floppy drives and other accessory boards consult the current full line price list.

SOFTWARE

Here is a partial listing of diskettes for the C4P and C8P. For a complete listing of diskettes and cassettes consult the current full line price list.

APPLICATIONS SOFTWARE

Disk	Description	Price
Game Disk 1	Arcade games	$ 29
Game Disk 2	Arcade games	29
Game Disk 3	Popular Conventional Computer games	29
Game Disk 4	Popular Conventional Computer games	29
Game Disk 5	Advanced Arcade games	29
Game Disk 6	Advanced Arcade games	29
Game Disk 7	Joy stick Arcade games	29
Game Disk 8	Animations and Cartoons (2 disk set)	29
Personal Disk 1	Checking/Savings/Loans/Etc.	29
Personal Disk 2	More personal programs	29
Education Disk 1	Educational games	29
Education Disk 2	BASIC tutor series	29
Education Disk 3	Tests/tutors/drills	29

BUSINESS SOFTWARE

Disk	Description	Price
Business Disk 1	Depreciation/return on investments etc....	$ 29
Business Disk 2	Mailing list/Address list/etc....	29
OS-WP2	Complete word processing system	200
OS-MDMS	65D based Data Base Manager and information management system. A must for business use.	49
MDMS-A/R	Accounts Receivable System	29
MDMS-A/P	Accounts Payable System	29
MDMS-Inventory	Inventory System	29
MDMS-Aux. 1	Sort/File packer/key File editor for ISAM	29

UTILITIES

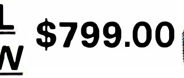
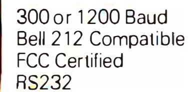
Disk	Description	Price
65D Aux. 1	Sort/packer/memory test/ disassembler	$ 29
Graphics 1	Color graphics utilities with high resolution plot package	29
Home Control 2	Advanced home control program using AC-12 and AC-17	29
DAC Routines 1	Music composition system with chord generation capability	39

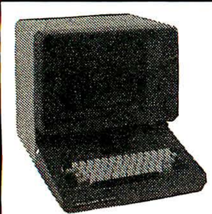
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Listing 4 continued:

```
01330 PRINT
01340 LET I2=I2+1
01350 LET T=I2
01360 PRINT "SHE HAS BEEN ASSIGNED THE NUMBER:"
01370 PRINT
01380 PRINT TAB(10);T
01390 GO TO 1450          ! GO BACK FOR NUMBER
01400 PRINT
01410 PRINT "PLEASE ENTER HER NUMBER:"
01420 INPUT T
01430 PRINT\PRINT
01440 LET T=0
01450 PRINT\PRINT
01460 PRINT "WHERE DID YOU GET THE INFORMATION ABOUT"
01470 PRINT D$;"'S BIRTH AND PARENTAGE?"
01480 PRINT "(BE SPECIFIC)"
01490 INPUT D1$
01500 !
01510 !          MARRIAGE CERTIFICATE INFORMATION
01520 !
01530 PRINT\PRINT
01540 PRINT "HOW MANY TIMES WAS ";D$;" MARRIED?"
01550 PRINT '(ENTER A DIGIT FROM 0 TO 99)'
01560 INPUT F
01570 IF F=0 THEN GO TO 1730
01580 FOR I=1 TO F
01590   PRINT\PRINT
01600   PRINT 'ENTER A DATE FOR MARRIAGE #';I;' (DA MO YR)'
01610   INPUT C$(I)
01620   PRINT
01630   PRINT "WHAT WAS THE SPOUSE'S FULL NAME?"
01640   PRINT '(USE MAIDEN NAME WHERE APPLICABLE)'
01650   INPUT G$(I)
01660   PRINT
01670   PRINT 'WHERE WERE THEY MARRIED?'
01680   INPUT K$(I)
01690   PRINT\PRINT
01700   PRINT "WHERE DID YOU GET THE INFORMATION ABOUT MARRIAGE #";F;"?"
01710   INPUT D2$(I)
01720 NEXT I
01730 IF F=0 THEN C$(I)='NOT APPLICABLE'
01740 IF F=0 THEN G$(I)='NOT APPLICABLE'
01750 !
01760 !          DEATH CERTIFICATE INFORMATION
01770 !
01780 PRINT\PRINT
01790 PRINT 'WHEN DID ';D$;' DIE (DA MO YR)?'
01800 PRINT "(IF YOU DON'T KNOW, ENTER 'UNKNOWN'."
01810 PRINT "IF HE OR SHE IS STILL LIVING, ENTER 'ALIVE'.)"
01820 INPUT J$
01830 IF J$='ALIVE' THEN GO TO 1900
01840 PRINT\PRINT
01850 PRINT 'WHERE DID HE/SHE DIE?'
01860 INPUT L$
01870 PRINT\PRINT
01880 PRINT "WHERE DID YOU GET THE INFORMATION ABOUT HIS/HER DEATH?"
01890 INPUT D3$
01900 IF J$='ALIVE' THEN L$='NOT APPLICABLE'
01910 PRINT\PRINT\PRINT
01920 !
01930 PUT #1
01940 CLOSE #1
01950 RETURN
01960 !
01970 !       PROCEDURE SUBROUTINE #2
01980 !          READ AND REVISE FILE
01990 !
02000 PRINT\PRINT
02010 PRINT "TASK: READ AND REVISE FILE INFORMATION"
02020 PRINT\PRINT
02030 OPEN 'GEN' AS FILE #1, SEQUENTIAL VARIABLE, ACCESS MODIFY, MAP GEN
```

Listing 4 continued on page 44

Listing 4 continued:

```
DATA, INVALID 130
02040 PRINT "DO YOU WISH TO SEARCH BY 'NAME' OR BY 'NUMBER'?"
02050 INPUT W2$
02060 PRINT
02070 IF W2$='NAME' THEN GO TO 2200
02080 IF W2$<>'NUMBER' THEN GO TO 2040
02090 PRINT "PLEASE ENTER THE NUMBER:"
02100 INPUT A1
02110 PRINT
02120 RESTORE #1
02130 LET Z5=0
02140 LET Z5=Z5+1
02150 IF Z5>I3 THEN PRINT "PERSON #";A1;"IS NOT IN THE FILE."
02160 IF Z5>I3 THEN GO TO 2940
02170 GET #1
02180 IF A1<>B THEN GO TO 2140
02190 GO TO 2340
02200 PRINT "IF YOU ARE LOOKING FOR SOMEONE IN PARTICULAR"
02210 PRINT "PLEASE ENTER HIS OR HER NAME.  IF YOU WANT"
02220 PRINT "TO READ THROUGH THE ENTIRE FILE, ENTER 'ALL'."
02230 INPUT P1$
02240 PRINT
02250 LET P2$=P1$
02260 RESTORE #1
02270 LET Z5=0
02280 LET Z5=Z5+1
02290 IF Z5>I3 THEN PRINT P1$;" IS NOT IN THE FILE."
02300 IF Z5>I3 THEN GO TO 2940
02310 GET #1
02320 IF P1$='ALL' THEN LET P2$=D$
02330 IF P2$<>D$ THEN GO TO 2280
02340 PRINT\PRINT
02350 PRINT 'GENEALOGICAL INFORMATION FOR:'
02360 PRINT D$
02370 PRINT "NUMBER:";B
02380 PRINT
02390 PRINT 'BORN: ';E$
02400 PRINT 'BIRTHPLACE: ';H$
02410 PRINT
02420 PRINT "FATHER: ";Q$;" (NUMBER:";R;")"
02430 PRINT "MOTHER: ";S$;" (NUMBER:";T;")"
02440 PRINT
02450 IF F=0 THEN GO TO 2530
02460 PRINT 'MARRIED TO:'
02470 FOR I=1 TO F
02480   PRINT '  ';G$(I)
02490   PRINT '      DATE: ';C$(I)
02500   PRINT '      PLACE: ';K$(I)
02510   PRINT
02520 NEXT I
02530 IF J$='ALIVE' THEN GO TO 2560
02540 PRINT "DEATH DATE: ";J$
02550 PRINT 'PLACE OF DEATH: ';L$
02560 PRINT\PRINT
02570 PRINT "RECORDS SOURCE:"
02580 PRINT "   BIRTH AND PARENTAGE: ";D1$
02590 FOR I=1 TO F
02600   PRINT "   MARRIAGE #";F;":";D2$(I)
02610 NEXT I
02620 IF J$='ALIVE' THEN GO TO 2640
02630 PRINT "   DEATH: ";D3$
02640 PRINT\PRINT
02650 !
02660 PRINT 'DO YOU WISH TO CHANGE ANYTHING?'
02670 INPUT P3$
02680 IF P3$='N' THEN GO TO 2930
02690 IF P3$='NO' THEN GO TO 2930
02700 !
02710 !          MENU FOR REVISIONS
02720 !
02730 PRINT
```

Listing 4 continued on next page

Listing 4 continued:

```
02740 PRINT 'PLEASE ENTER THE NUMBER OF THE ITEM'
02750 PRINT 'YOU WISH TO CHANGE:'
02760 PRINT
02770 PRINT '    1) NAME AND NUMBER'
02780 PRINT '    2) BIRTH AND PARENTAGE'
02790 PRINT '    3) MARRIAGE INFORMATION'
02800 PRINT '    4) DEATH INFORMATION'
02810 PRINT '    5) NOTHING'
02820 PRINT
02830 INPUT P4
02840 IF P4=1 THEN GOSUB 4190
02850 IF P4=2 THEN GOSUB 4300
02860 IF P4=3 THEN GOSUB 4460
02870 IF P4=4 THEN GOSUB 4670
02880 IF P4=5 THEN GO TO 2940
02890 PRINT
02900 !
02910 PRINT 'DO YOU WISH TO MAKE OTHER CHANGES?'
02920 GO TO 2670
02930 UPDATE #1, MAP 140
02940 PRINT\PRINT
02950 !
02960 PRINT 'WOULD YOU CARE TO EXAMINE ANOTHER RECORD?'
02970 INPUT P$
02980 IF P$='Y' THEN IF P1$<>'ALL' THEN GO TO 2030
02990 IF P$='YES' THEN IF P1$<>'ALL' THEN GO TO 2030
03000 IF P$='Y' THEN GO TO 2310
03010 IF P$='YES' THEN GO TO 2310
03020 !
03030 CLOSE #1
03040 RETURN
03050 !
03060 !        PROCEDURE SUBROUTINE #3
03070 !            LINK PEDIGREE BY NUMBER
03080 !
03090 PRINT\PRINT
03100 PRINT "TASK: LIST PEDIGREE"
03110 PRINT\PRINT
03120 OPEN 'GEN' AS FILE #1, SEQUENTIAL VARIABLE, MAP GENDATA, INVALID
130
03130 LET I4=0
03140 PRINT "WHOSE PEDIGREE WOULD YOU LIKE PRINTED?"
03150 PRINT "(ENTER HIS/HER NUMBER, PLEASE)"
03160 INPUT X1
03170 PRINT\PRINT
03180 PRINT "THE SYMBOL 'F' STANDS FOR 'FATHER'"
03190 PRINT "THE SYMBOL 'M' STANDS FOR 'MOTHER'"
03200 PRINT\PRINT
03210 !
03220 !        FIND PARENTS AND LIST
03230 !
03240 LET I4=I4+1
03250 IF I4>I3 THEN PRINT "PERSON #";X1;"IS NOT LISTED IN THE FILE"
03260 IF I4>I3 THEN GO TO 4150
03270 GET #1
03280 IF B<>X1 THEN GO TO 3240
03290 PRINT TAB(15);"PEDIGREE FOR PERSON #";B
03300 PRINT
03310 PRINT D$
03320 PRINT
03330 PRINT TAB(5);'F:';O$;'(NUMBER:';R;')'
03340 PRINT TAB(5);'M:';S$;'(NUMBER:';T;')'
03350 PRINT
03360 !
03370 !        FIND GRANDPARENTS AND LIST
03380 !
03390 LET X2=R
03400 LET X3=T
03410 LET I5=0
03420 LET I12=0
03430 IF X2<>0 THEN I12=I12+1
```

Listing 4 continued on page 46

Listing 4 continued:

```
03440 IF X3<>0 THEN I12=I12+1
03450 IF I12=0 THEN GO TO 4150
03460 LET I4=I4+1
03470 IF I4=I3 THEN GOSUB 4840
03480 GET #1
03490 IF X2=B THEN GO TO 3520
03500 IF X3=B THEN GO TO 3600
03510 GO TO 3460
03520 PRINT TAB(10);'FF:';Q$;'(NUMBER:';R;')'
03530 PRINT TAB(10);'FM:';S$;'(NUMBER:';T;')'
03540 PRINT
03550 LET X4=R
03560 LET X5=T
03570 LET I5=I5+1
03580 IF I5<I12 THEN GO TO 3460
03590 IF I5>=I12 THEN GO TO 3730
03600 PRINT TAB(10);'MF:';Q$;'(NUMBER:';R;')'
03610 PRINT TAB(10);'MM:';S$;'(NUMBER:';T;')'
03620 PRINT
03630 LET X6=R
03640 LET X7=T
03650 LET I5=I5+1
03660 IF I5<I12 THEN GO TO 3460
03670 IF I5>=I12 THEN GO TO 3730
03680 LET I15=0
03690 PRINT
03700 !
03710 !       FIND GREAT GRANDPARENTS AND LIST
03720 !
03730 LET I5=0
03740 LET I12=0
03750 IF X4<>0 THEN I12=I12+1
03760 IF X5<>0 THEN I12=I12+1
03770 IF X6<>0 THEN I12=I12+1
03780 IF X7<>0 THEN I12=I12+1
03790 IF I12=0 THEN GO TO 4150
03800 LET I4=I4+1
03810 IF I4>I3 THEN GOSUB 4840
03820 IF I16>4 THEN PRINT "FURTHER TRACING OF
THE PEDIGREE IS IMPOSSIBLE."
03840 IF I16>4 THEN GO TO 4150
03850 GET #1
03860 IF X4=B THEN GO TO 3910
03870 IF X5=B THEN GO TO 3970
03880 IF X6=B THEN GO TO 4030
03890 IF X7=B THEN GO TO 4090
03900 GO TO 3800
03910 PRINT TAB(15);'FFF:';Q$;'(NUMBER:';R;')'
03920 PRINT TAB(15);'FFM:';S$;'(NUMBER:';T;')'
03930 PRINT
03940 LET I5=I5+1
03950 IF I5<I12 THEN GO TO 3800
03960 IF I5>=4 THEN GO TO 4150
03970 PRINT TAB(15);'FMF:';Q$;'(NUMBER:';R;')'
03980 PRINT TAB(15);'FMM:';S$;'(NUMBER:';T;')'
03990 PRINT
04000 LET I5=I5+1
04010 IF I5<I12 THEN GO TO 3800
04020 IF I5>=I12 THEN GO TO 4150
04030 PRINT TAB(15);'MFF:';Q$;'(NUMBER:';R;')'
04040 PRINT TAB(15);'MFM:';S$;'(NUMBER:';T;')'
04050 PRINT
04060 LET I5=I5+1
04070 IF I5<I12 THEN GO TO 3800
04080 IF I5>=I12 THEN GO TO 4150
04090 PRINT TAB(15);'MMF:';Q$;'(NUMBER:';R;')'
04100 PRINT TAB(15);'MMM:';S$;'(NUMBER:';T;')'
04110 PRINT
04120 LET I5=I5+1
04130 IF I5<I12 THEN GO TO 3800
04140 !
04150 CLOSE #1
04160 RETURN
04170 !
04180 !       REVISION SUBROUTINE #1
04190 !          CHANGE NAME AND NUMBER
04200 !
04210 PRINT\PRINT
04220 INPUT 'NAME:';D$
04230 PRINT
04240 INPUT 'NUMBER:';B
04250 RETURN
04260 !
04270 !       REVISION SUBROUTINE #2
04280 !          CHANGE BIRTH INFORMATION
04290 !
04300 ! CHANGE BIRTH INFORMATION
04310 PRINT\PRINT
04320 INPUT 'BIRTHDATE: ';E$
04330 PRINT
04340 INPUT 'BIRTHPLACE: ';H$
04350 PRINT
04360 INPUT "FATHER'S NAME";Q$
04370 INPUT "FATHER'S NUMBER";R
04380 PRINT
04390 INPUT "MOTHER'S NAME";S$
04400 INPUT "MOTHER'S NUMBER";T
04410 PRINT
04420 INPUT "SOURCE OF INFORMATION";D1$
04430 RETURN
04440 !
04450 !       REVISION SUBROUTINE #3
04460 !          CHANGE MARRIAGE INFORMATION
04470 !
04480 PRINT\PRINT
04490 INPUT "WHICH MARRIAGE (ENTER NUMBER)";I
04500 PRINT
04510 PRINT "DATE OF MARRIAGE #";I;
04520 INPUT C$(I)
04530 PRINT
04540 INPUT "SPOUSE'S NAME";G$(I)
04550 PRINT
04560 INPUT "PLACE OF MARRIAGE";K$(I)
04570 PRINT
04580 PRINT "SOURCE OF INFORMATION?"
04590 INPUT D2$(I)
04600 PRINT
04610 PRINT "FOR HOW MANY OF THIS PERSON'S MARRIAGES DOES"
04620 PRINT "THE FILE NOW CONTAIN INFORMATION?"
04630 INPUT F
04640 RETURN
04650 !
04660 !       REVISION SUBROUTINE #4
04670 !          CHANGE DEATH INFORMATION
04680 !
04690 PRINT\PRINT
04700 PRINT "DEATH DATE"
04710 PRINT "(IF YOU DON'T KNOW, ENTER 'UNKNOWN'.  IF"
04720 PRINT "HE OR SHE IS STILL ALIVE, ENTER 'ALIVE'.)"
04730 INPUT J$
04740 IF J$='ALIVE' THEN GO TO 4800
04750 PRINT
04760 INPUT "PLACE OF DEATH";L$
04770 PRINT
04780 PRINT "SOURCE OF INFORMATION?"
04790 INPUT D3$
04800 RETURN
04810 !
04820 !       RESTORATION OF FILE POINTER
04830 !
04840 RESTORE #1
04850 RETURN
04860 !
04870 !       PROCEDURE SUBROUTINE #4
04880 !          END THE PROGRAM
04890 !
04900 PRINT
04910 END  ■
```

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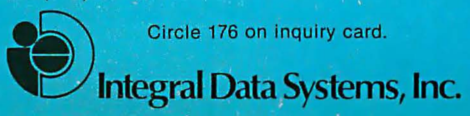
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We all know there are many reasons for increasing utility costs, from higher oil prices to billion dollar Environmental Protection Agency regulations, but that doesn't make the paying any easier.

There has been much rhetoric about personal conservation and elimination of waste. In order to formulate an effective and efficient plan for conservation of electricity in your home or business, you need to know the cost of operation for individual appliances and other electrical devices.

The Power program (see listing 1) calculates from your electric bill your cost per kilowatt-hour of power used. The program then generates the cost per month and per hour to operate specific appliances, given their electrical specifications.
name plate fastened somewhere on the device. However, some appliances list amps rather than watts. The Power program contains an option for calculating wattage from amperage and voltage.

You will also need the listed voltage, which will usually appear as 120 V or 120 V AC. If voltage is given in a range of, say, 110 V to 130 V, it means that the appliance will operate at any voltage within the range. In the program, use the voltage which is running through the circuit that the appliance is plugged into.

A table of household appliances is provided for your convenience in gathering and recording needed inputs and monthly costs. A word of warning about the estimation of hours an appliance is operated in a month: I repeatedly underestimate this time, perhaps because it seems that months fly by and hours are inconsequential. But there are 720 hours in a 30-day month and in order to make this analysis useful one must realistically estimate hours of use.

Another problem can exist in obtaining an estimated wattage for some of the high power consumption devices such as electric furnaces, or air conditioning units. New models, today, will have many of their technical specifications listed in information sheets available to the public. Among these specifications will be an estimate of total system power requirement in kilowatts. For the sample run in listing 2, I used the total system kilowatts that were listed for a heat pump during its cooling cycle, given various other criteria such as outdoor temperature.

The listed power requirement was 6.3 kilowatts; however, the program requires that watts, not kilowatts, be entered. If the data on your equipment is in kilowatts, multiply by 1,000 to obtain watts.

Home electric furnaces are usually rated at 5 kW and up depending on how much heat is required. A very rough estimate for an average home with an electric furnace is 15 to 25 kW, or 15,000 to 25,000 W. If you cannot obtain your particular system's wattage, you might try using this average, but it could be significantly different from your actual system's draw.

Sample Run

The Power program, listing 1, is written in North Star BASIC. There are no instructions for providing hardcopy, but if you desire one you could place a statement for selecting your printer at, perhaps, line 415. You could then select the video monitor again at line 495.

The program presents two options. If you already know the cost per kilowatt-hour the utility company uses to calculate your bill, you can select option 2. This allows you to input the cost per kilowatt-hour by jumping to the main portion of the program.

If you do not know the kilowatt-hour rate, select option 1, as in the example. Actually, your cost per kilowatt-hour will probably vary from one month to the next because of the rating structure systems used by power companies, especially if time of day rates are being used. So, you just might

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Circle 163 on inquiry card.

out of curiosity calculate your cost per kilowatt-hour each month as you get your bill and see if it is changing. Sometimes there are different rate block structures between summer and winter.

After entering option 1, you are prompted to input the ending kilowatt-hour reading from a recent electric bill (66,239, for example). Next, input the previous reading, which should also appear on the bill (62,213, for example).

The program prompts you to enter the amount of the bill. If your utility company sells both electricity and gas to you, be certain that only the electric portion of the bill is entered. There may also be a fuel adjustment cost figured into the total cost, and sales tax will probably appear on the bill. It's up to you if you want to include these figures in the total cost you enter into the program. If you do include them, you can apportion their cost to individual appliances. The cost per kilowatt-hour will probably not be affected significantly whether you do or

Listing 1: North Star BASIC program to calculate the cost of running electrical appliances. The program helps you determine the operating cost of an appliance based on the average wattage or the voltage and amperage ratings of the product.

```
10 DIM D$(1)
20 PRINT "        THIS PROGRAM CALCULATES POWER USAGE AND COSTS"
30 PRINT\ PRINT
40 PRINT "                 PROGRAM OPTIONS:"
50 PRINT
60 PRINT "              1. CALCULATE COST PER KILOWATT HOUR"
70 PRINT "              2. CALCULATE APPLIANCE POWER USAGE AND COST"
80 PRINT
90 INPUT "                  SELECT 1 OR 2 ",A
100 PRINT
110 ON A GOTO 120, 200
120 INPUT "ENTER ENDING KWH READING FROM ELECTRIC BILL ",E
130 PRINT
140 INPUT "ENTER BEGINNING KWH READING FROM BILL ",B
150 PRINT
160 INPUT "ENTER AMOUNT OF ELECTRIC BILL ",T
170 PRINT
180 LET C = T/(E-B)
190 GOTO 220
200 INPUT "ENTER COST PER KWH ",C
210 PRINT\ PRINT
220 PRINT "                 OPTIONS"
230 PRINT
240 PRINT "              1. CALCULATE WATTS"
250 PRINT "              2. INPUT WATTS"
260 PRINT
270 INPUT "                 SELECT 1 OR 2 ",A
280 PRINT
290 ON A GOTO 300, 350
300 INPUT "ENTER APPLIANCE VOLTAGE ",V
310 PRINT
320 INPUT "ENTER APPLIANCE AMP DRAW ",Z
330 LET W = Z * V
340 GOTO 360
350 INPUT "ENTER APPLIANCE WATTAGE ",W
360 PRINT
370 INPUT "ENTER NUMBER OF HOURS USED IN TIME PERIOD ",H
380 PRINT
390 LET K = (W*H)/1000
400 LET D = K * C
410 PRINT\ PRINT\ PRINT
420 PRINT "  COST PER KILOWATT HOUR OF USAGE = ",C
430 PRINT
440 PRINT "  KILOWATT HOURS OF POWER USAGE   = ",K
450 PRINT
460 PRINT "  MONTHLY COST OF THAT POWER USAGE= ",D
470 PRINT
480 PRINT "  COST PER EST. HOUR'S USE        = ",D/H
490 PRINT\ PRINT
500 INPUT"DO YOU WISH TO CALCULATE ANOTHER APPLIANCE (Y/N)? ",D$
510 IF D$ = "Y" THEN 210
520 END
```

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Software Authors—see separate ad on page 120.

Table 1: This table can be used to collect data from your appliances for the Power program.

Appliance Power Table

Appliance	Watts or amps and volts	Hours used per month	Monthly cost	Cost per hour of use
Coffee maker				
Microwave oven				
Oven				
Range				
Dishwasher				
Refrigerator				
Freezer				
Clothes dryer				
Clothes washer				
Electric blanket				
Stereo				
Television				
Lawn mower				
Electric saw				
Lighting				
Sewing machine				
Air conditioner				
Dehumidifier				
Electronic air filter				
Fan				
Electric furnace				
Electric hot water heater				
Waterbed heater				
Swimming pool filter				

Listing 2: A sample run using the Power program.

```
          THIS PROGRAM CALCULATES POWER USAGE AND COSTS

                    PROGRAM OPTIONS:

              1. CALCULATE COST PER KILOWATT HOUR
              2. CALCULATE APPLIANCE POWER USAGE AND COST

                    SELECT 1 OR 2 1

ENTER ENDING KWH READING FROM ELECTRIC BILL 66239

ENTER BEGINNING KWH READING FROM BILL 62213

ENTER AMOUNT OF ELECTRIC BILL 170.71

                    OPTIONS

                1. CALCULATE WATTS
                2. INPUT WATTS

                    SELECT 1 OR 2 1

ENTER APPLIANCE VOLTAGE 120

ENTER APPLIANCE AMP DRAW 3

ENTER NUMBER OF HOURS USED IN TIME PERIOD 100
```

Listing 2 continued on page 54

do not include these additional costs. In the sample run, we will enter $170.71 for the total cost of electricity.

The program now presents two more options: to calculate watts from amps and volts, or to input watts. In the example we wish to calculate watts, so we enter 1. We are prompted to enter the appliance voltage, in this case 120. Then we enter the amps, in this case 3. The number of hours used a month is estimated at 100.

The calculations are quickly done and four results are presented. The inputs in this example were for a sewing machine and now I know what it's costing me to keep repairing my 5 year old's torn clothes. The first result shown is the cost per kilowatt-hour, which was calculated from the utility bill. Notice the E-02 at the end of the number. This floating point notation means that you move the decimal point two places to the left for a dollars and cents answer. Therefore, the utility company rate on my last bill averaged out to be $0.04 per kilowatt-hour of use.

The next result is the number of kilowatt-hours of power used for the sewing machine. This is the product of the kilowatt draw times the estimated hours of use. Your electric meter records the total number of kilowatt-hours of usage; this is what appears on your bill. In this case, 36 kWh of my total usage were due to the sewing machine.

The monthly cost of using the machine is shown next. In this example, it cost me $1.53 to operate my sewing machine for 100 hours during the month. That doesn't seem too bad. In fact, the next result presented shows me that one hour's usage of the machine costs me about 1½ cents. That's a bargain!

The program now asks if we wish to calculate costs for another appliance. To do so we enter Y.

The program already has calculated the cost per kilowatt-hour, so we loop back to the options for entering or calculating wattage. The next appliance I want to check is a portable color television for which I know the wattage. So, we enter option 2 for this prompt.

The wattage for the television is 240, so this figure is entered as prompted. The estimated hours of usage in a month are 200. The results show me that running that television for 200 hours cost me $2.04 and the cost for each hour's use was $0.01.

I want to enter a third appliance, a heat pump air conditioner. The watts are 6,300 and the estimated hours of use were 300. The results are significant, revealing a total cost of $80.14 and a cost per hour of $0.27. You can see the implications for conservation.

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Listing 2 continued:

```
   COST PER KILOWATT HOUR OF USAGE =  4.2401888E-02

   KILOWATT HOURS OF POWER USAGE   =  36

   MONTHLY COST OF THAT POWER USAGE=  1.526468

   COST PER EST. HOUR'S USE        =  .01526468

DO YOU WISH TO CALCULATE ANOTHER APPLIANCE (Y/N)? Y

                 OPTIONS

              1. CALCULATE WATTS
              2. INPUT WATTS

                 SELECT 1 OR 2 2

ENTER APPLIANCE WATTAGE 240

ENTER NUMBER OF HOURS USED IN TIME PERIOD 200

   COST PER KILOWATT HOUR OF USAGE =  4.2401888E-02

   KILOWATT HOURS OF POWER USAGE   =  48

   MONTHLY COST OF THAT POWER USAGE=  2.0352906

   COST PER EST. HOUR'S USE        =  1.0176453E-02

DO YOU WISH TO CALCULATE ANOTHER APPLIANCE (Y/N)? Y

                 OPTIONS

              1. CALCULATE WATTS
              2. INPUT WATTS

                 SELECT 1 OR 2 2

ENTER APPLIANCE WATTAGE 6300

ENTER NUMBER OF HOURS USED IN TIME PERIOD 300

   COST PER KILOWATT HOUR OF USAGE =  4.2401888E-02

   KILOWATT HOURS OF POWER USAGE   =  1890

   MONTHLY COST OF THAT POWER USAGE=  80.139568

   COST PER EST. HOUR'S USE        =  .26713189

DO YOU WISH TO CALCULATE ANOTHER APPLIANCE (Y/N)? N
```

Pay As You Turn On

After you have calculated individual power costs for appliances, the next step is to use the information to conserve energy and lower your bill. The first thing that should strike you is how little most appliances really cost to operate per month. The second impact will be how expensive certain other items are to use.

Look at the appliance table and decide if you can decrease the hours used for these most costly items. Set a lower hour goal and then recalculate the monthly cost. When you think you have a workable goal that will help your budget, try to realize those desired hours of usage. Achieving the goals will demand your own personal determination and discipline. The Power program can show you problem areas and help establish targets and priorities, but that's where your battle really begins.

Perhaps, on/off timers would be helpful in regulating certain devices. Another approach that has been attempted is a "pay as you turn on" method. With the cost per hour of use figure from the program, you can charge yourself accordingly for the privilege of turning on specific appliances, such as televisions, washing and drying machines, ovens, ranges, electric lawn mowers or stereos (even your personal computer, heaven help us!).

Putting pennies into a bank on top of the television may sound a bit primitive but perhaps it would make one check the television listings in the paper more carefully before switching on the set and turning the selector to see if there's anything on worth watching.

I hope the Power program will aid in energy conservation. But its informational possibilities, alone, make it useful. At least you can know more clearly which devices are most power hungry and by how much. This is certainly better than receiving your electric bill and simply grumbling in the dark.■

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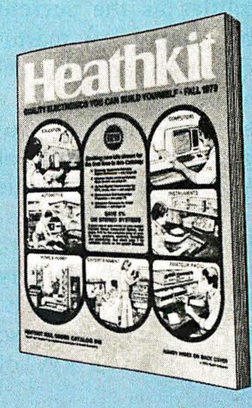
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Self-Refreshing LED Graphics Display

Steve Ciarcia
POB 582
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Light emitting diodes (LEDs) have been in use for a number of years. When first introduced they, like transistors, were very expensive, and were used only for special applications. Fortunately, manufacturing techniques have advanced to a point where a single red LED costs less than $0.10. A further achievement is the availability of yellow, orange, and green LEDs.

When we think of graphics displays, we usually think of television-type video displays. All of the more popular personal computing systems have video displays, with the majority of them supporting graphics. It is not inconceivable that we will eventually see economical, flat, high-resolution LED displays which have the same capabilities as the current cathode ray tube displays. A manufacturing breakthrough will be required before this is a reality.

There have been some military programs requiring the construction of such displays. A few years ago, while still a member of the military-industrial complex, I worked on a bid to build a 10 by 10 foot LED display comprised of 792,000 discrete LEDs. My calculations at the time predicted that it would take about 3 kW of power to run.

This article is not going to describe how to replace your television screen with a flat panel LED display, but will attempt something a bit more modest. The concept of LED graphics is not that far in the future. While we're waiting for technology to catch up with interest, we can experiment with the concept on a limited scale and analyze the various logic alternatives. A side benefit is the construction of an 8 by 16 LED display as your newest peripheral device.

Light Emitting Diode Displays

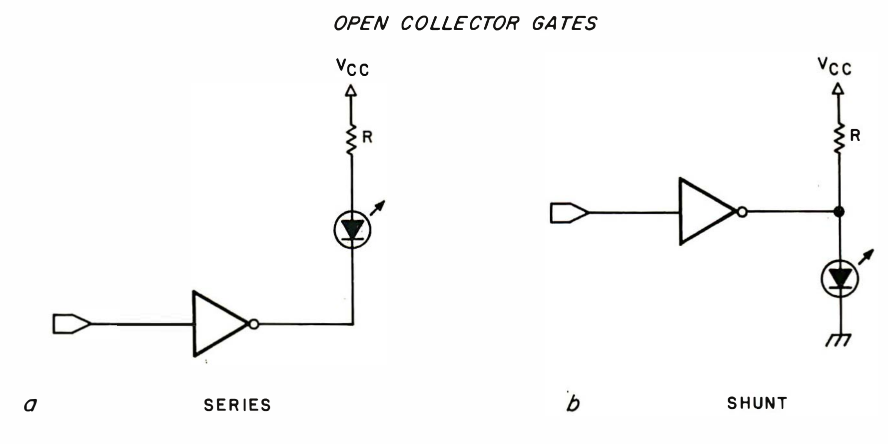
We all know about LEDs, correct? They are the little red things that glow when a current is passed through them. Most of us even remember to use a resistor to limit the average current to around 20 mA. What many people don't realize is that an LED can also be driven by much higher currents if *pulsed* on and off, rather than run continuously. This is a significant fact to keep in mind when building a large LED display.

Figure 1 shows standard methods for using transistor-transistor logic (TTL) to drive LEDs. The TTL gate can be used to either sink or source current to the LED without external transistors. In general, TTL devices will sink 16 thru 20 mA, while some go as high as 50 mA. (It's best to check manufacturer specification sheets if you are unsure.) Open collector gates, shown in figures 1a and 1b, can be wired in either series or shunt configuration.

In figure 1a the circuit is completed and the LED is lit when a logic 1 is applied to the inverter input. The low-level output of the gate also provides a path to ground for the LED. Figure 1b, on the other hand, is a shunt circuit and exhibits an opposite logic. Normally current flow is through the LED, and it is lit. When a logic 1 is applied to the inverter, the resultant low output shunts the current to ground, shutting off the LED. There are advantages to both methods which I will discuss later.

Logic parts such as the 7400 NAND gate or 74LS04 inverter have active pull-up totem pole outputs. Rather than just a single NPN transistor like the open collector types, these have 2 transistors connected in series between the supply voltage V_{CC} and ground. Depending upon the logic state, only 1 of the 2 transistors will be conducting. Generally speaking, series and shunt LED drivers are more easily built with open collector devices. Figure 1d, however, cannot be accomplished with open collector logic, because this circuit depends upon the internal active pull-up resistance to source current to the LED. The exact amount of available current depends upon the logic type.

LOGIC TYPES	I_{OUT} LOW
74S ≤	20mA
74H ≤	20mA
74 ≤	16mA
74LS ≤	8mA
74L ≤	3.6mA
CMOS 4049 ≥	3mA
CMOS 4009 ≥	8mA



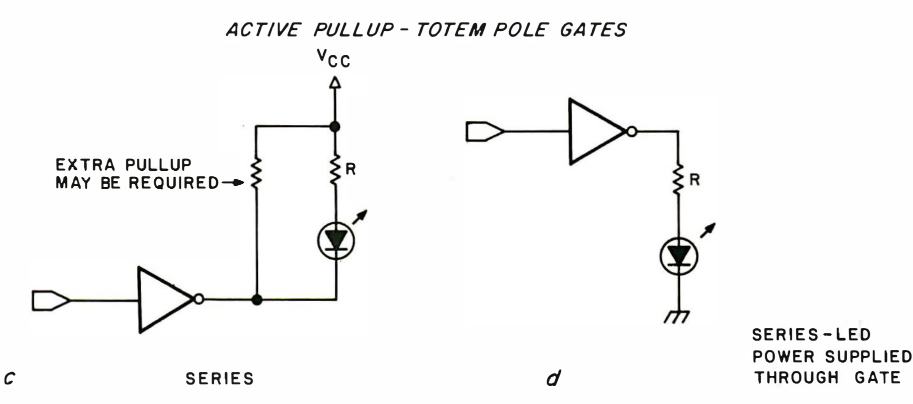


Figure 1: There are several ways of driving LED displays. A method employing a series circuit with an open collector gate turns on the LED when a logic 1 is applied to the inverter input. The shunt version of the open collector circuit turns on the LED when a logic 0 is applied to the inverter input.

If active pull-up totem-pole gates are used (the kind found in nearly all TTL gates), the circuits may be wired only in series. In figure 1c the voltage needed to power the LED comes from the supply voltage V_{CC}. In figure 1d the LED is wired in series, and the power to light the LED is supplied through the logic gate. Typical output currents are given for various types of logic in the accompanying table.

Returning to the discussion of displays using LEDs, it is quite simple to take the logic concepts of figure 1 and put them to use. Figure 2 outlines a simple 8-bit LED driver with latched output. It is suitable as a bar-graph display, 8-level indicator, or 8-item annunciator. We always think first of using the video display to display the results of a logic decision, but if the result is simply yes or no, the binary answer can be signified on an LED. In my own case, such an 8-bit display is used to keep track of enabled peripherals and I/O (input/output) channels.

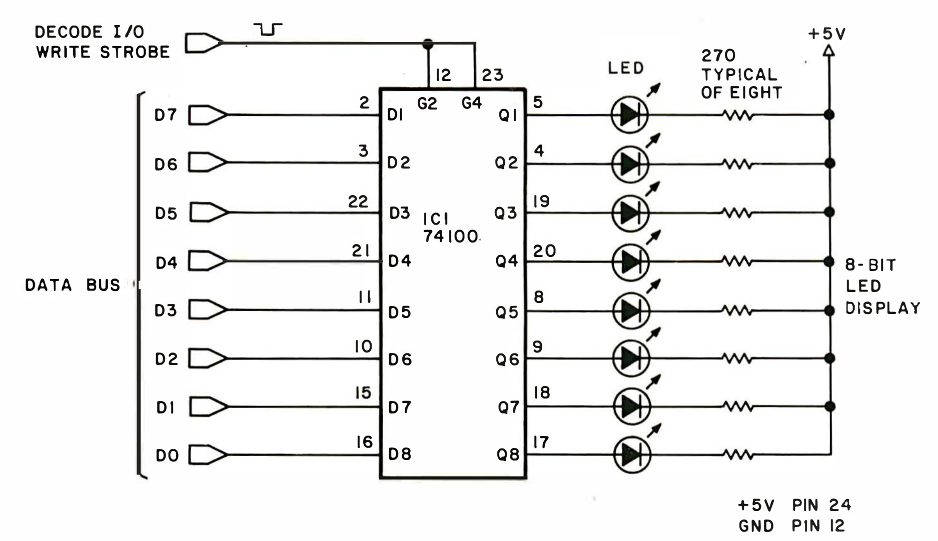


Figure 2: A simple 8-bit, latched-output LED display, suitable for use in computer-controlled bar graphs or 8-level indicators.

Larger LED Displays Have to Be Multiplexed

Using 8 LEDs probably doesn't excite too many people, especially when I started out with a number like 792,000. The 8 LEDs can, of course, be expanded to 64 by multiplying this same circuit 8-fold. With an average current of 15 mA for each LED and 100 mA for each 74100 dual 4-bit latch, the grand total to run it is slightly under 2 A at 5 V. This fact, and the necessity of having 64 resistors as well, leads us to consider some other means of driving the LEDs.

The logical alternative to continuous operation is time-multiplexed operation. For an LED with a 20 mA continuous current rating, this means



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Section 2 — Overview

SECTION 2. AN OVERVIEW OF WordStar

WordStar is a CP/M compatible, screen oriented word processing system with integrated printing. Both initial entry of text and alteration of previously entered text are performed directly on screen. Most formatting functions take place immediately, resulting in the display of a true print image; additional enhancements are performed during printout.

WordStar's **EDIT FUNCTION** is used to create and alter documents stored on diskette. Features of the edit function include the following:

Video Editing: a portion of the document being entered or corrected is always shown on the CRT screen; additions and corrections are immediately displayed. Text entry is accomplished merely by typing the desired text; command functions such as cursor motion or deletion of text are quickly accomplished with visual feedback.

Automatic Disk Buffering: the size of a document is not limited by the amount of RAM memory in your computer, but by disk capacity. Text is brought into RAM as required, with no operator intervention or concern.

On-screen Text Formatting: text is displayed on the screen as it will appear when printed, thereby facilitating review and correction of printed copy appearance before actually printing. On-screen text formatting is accomplished with the aid of the following three features:

Word Wrap: paragraphs may be entered at high speed without striking Carriage Return; when a word you type exceeds the right margin you've set, WordStar automatically moves the word being entered to the next line and justifies and redisplays the line just completed. The RETURN key is used only to indicate the end of a paragraph, blank line, or other point where a permanent line break is desired. Thus, the typist need not break rhythm by concern for the end of the line or feeling the necessity of looking up from the material being transcribed.

Automatic Margination, Justification, Line Spacing, Centering: with word wrap in effect, each completed line is automatically adjusted to fit user-settable left and right margins, justified (right-aligned) unless the user has selected ragged-right format, and, optionally, double-spaced or triple spaced. A line of text can be centered between the current left and right margins with a keystroke command.

Reform Paragraph Command: text from the cursor position to the end of the paragraph may be "reformed" on command to change the margins or line spacing, to change from ragged right to justified or vice versa, or to clean up after alterations.

Powerful Editing Commands: in addition to the basic functions - cursor motion, scrolling, text deletion by character, word, or line, and selection of insertion or overtyping - WordStar's editing commands include set/clear **variable tab stop, block move,** block copy, block delete, **find, replace,** write to and read from **additional files,** and set/return to **place markers.**

2-1

Section 2 — Overview

Print Enhancements: Underline, Double Strike, **Boldface,** and ~~Strikeout~~ are generated at print time, in response to special characters imbedded in the document. WordStar can print these enhancements on regular printers as well as on Daisy-wheel printers. During editing, the special characters used to invoke the enhancement are displayed at the beginning and end of the affected text, allowing most standard CRT terminals to be used.

Underline, double strike, boldface, and strikeout may be used freely **in mid-paragraph** as well as in separate lines such as titles; use of these features is completely compatible with word wrap and paragraph reform.

Subscripts, Superscipts, Variable Character Pitch (pica, elite, or your choice of number of characters per inch), and **Variable Line Height** (6, 8, or your choice of lines per inch) are fully supported on Daisy-wheel and other incremental printers, and within limitations on Teletype-like printers.

Print enhancements many be used in all **combinations.** For example, underlined and boldfaced **subscripts** are supported.

Microspace Justification: when printing justified text on a daisy wheel printer, the white space in each line is evenly distributed between the words and characters for superior appearance. On printers not capable of incremental spacing, and, in any case on the CRT display while editing, justification is accomplished by varying the number of blanks between words.

You are now reading an example of a document prepared entirely with WordStar. This manual was entered and revised using the edit function; camera-ready copy was printed on a daisy-wheel printer.

Operator Options: when invoking the print function, the operator may specify a starting page number, use of "form feed" characters, pausing between pages for single-sheet (e.g. letterhead) paper loading, printing exact file contents without page formatting, and outputting to a disk file instead of the printer. Print operation can be suspended or aborted at any time, whether or not a document is being edited, while the printing is being performed.

Additional **WordStar** features include:

Keyboard Buffering: if the operator types faster than the screen display can respond, the keystrokes are caught and saved until they can be processed. Further, screen updating is usually suspended until WordStar catches up with processing all the keystrokes. Thus, the operator can enter text or type commands at high speed, then pause when he/she wishes to see the latest screen display. The only exception to this is during disk I/O, which is indicated by a message at the top of the screen as well as the usual noise from the disk drive.

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2-3

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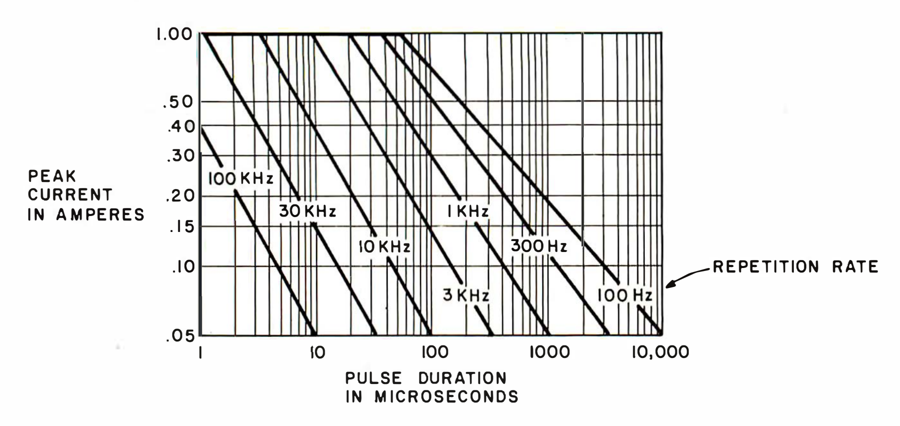


Figure 3: A typical curve for a T-1 ¾ LED showing the relationship between maximum current and pulse width for specified pulse rates.

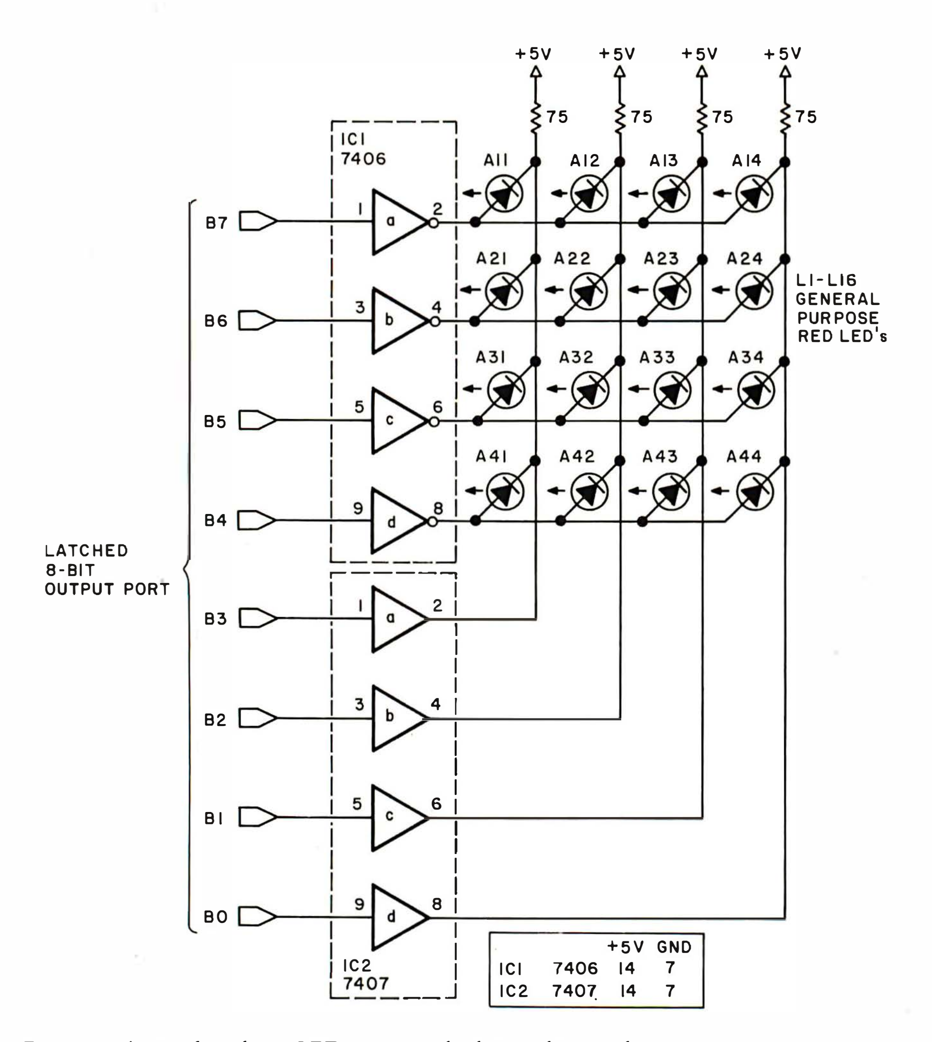


Figure 4: A simple 4 by 4 LED matrix which is software driven.

we'd raise the peak current (I_{pk}) and reduce the duty cycle. If the duty cycle were 25%, then 4 LEDs could be multiplexed through the same driver, and all would appear to operate continuously. The more LEDs in the loop, the lower the duty cycle. To maintain the same brightness, the current is raised again to produce a reasonable average current. It reaches a point of diminishing returns when the duty cycle becomes so low that the peak current required to maintain a sufficient average current burns out the LED due to excessive power dissipation.

For pulsed applications, a curve of maximum peak current, pulse width, and repetition rate can be used to determine the maximum recommended operating conditions. Figure 3 illustrates a typical curve for a T-1¾ LED such as that used in this article. It is determined by comparing peak and average junction temperatures during strobed operations, and maintaining a limit equivalent to the maximum allowable DC conditions. At any specified repetition rate, the relationship between maximum current and pulse width is shown. If, for example, 5 LEDs were to be multiplexed, and brightness maintained equivalent to a 10 mA continuous current, each would have to be pulsed for 1 ms 100 times a second, with a peak current of 100 mA.

Figure 4 shows a simple 4 by 4 LED matrix which demonstrates this concept. It also serves to point out some of the limitations of this bare-bones approach. A latched 8-bit parallel output port is all that is necessary to run this display. Four bits define the column and 4 bits define the row. Multiplexing is done in software.

To turn on the LED at location A22, bits B2 and B6 would be set to a logic 1, while lighting A43 would require a combination of bits B1 and B4. The logical process is essentially an extension of the shunt circuit described in figure 1.

A microprocessor can be used to control an X,Y addressable array of LEDs. The external circuitry required is minimal, and relatively little processor time is used to refresh the array. The technique used is to periodically strobe a row and column address into an output latch. At a predetermined later time, new information concerning the next display point is sent out to the latch. If this addressing can proceed faster than 100 times per second, then the entire display will appear to be DC driven. Usually, refresh timing is handled through interrupts.

There are important considerations to keep in mind when building this type of circuit. 7406 and 7407 inverting and noninverting drivers are not high current drivers, but they can sink 40 mA. They were chosen because they are cheap and available. If brightness is a problem and peak current has to be increased, these drivers can be replaced with transistors which have a higher current rating, or more gates of the same type can be added in parallel. The fact

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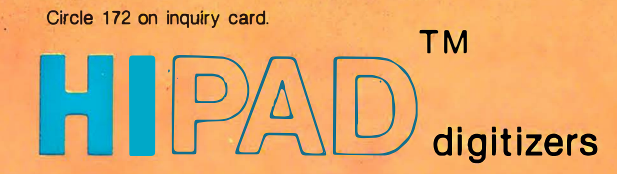


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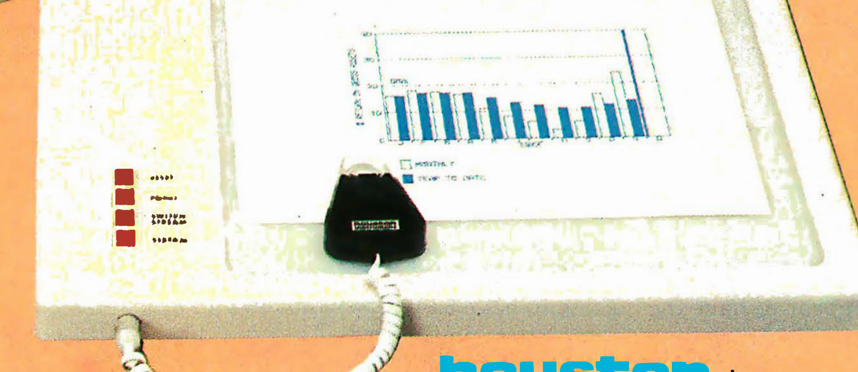
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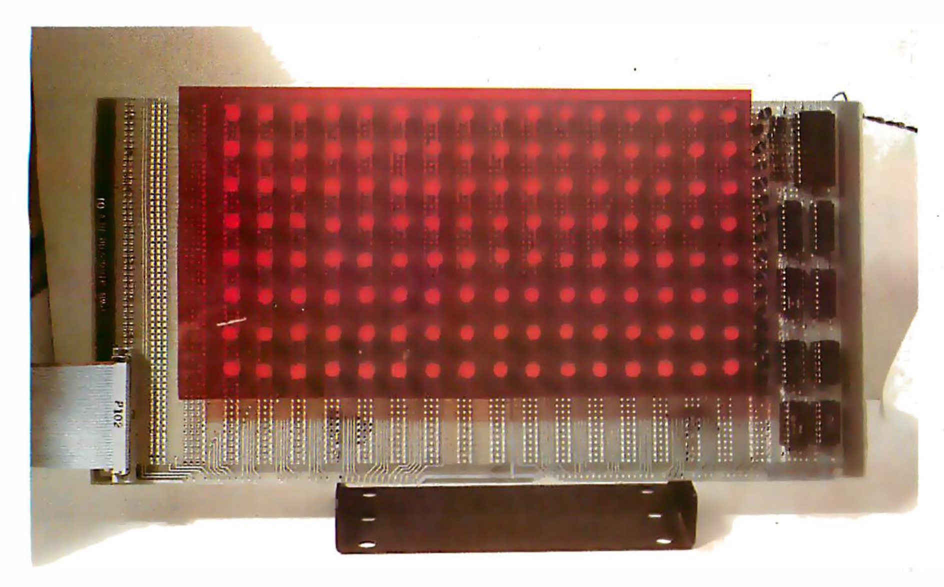


Photo 1: The prototype board for the light emitting diode (LED) display showing all of the LEDs turned on. A piece of red plastic is held in front of the display to increase visibility.

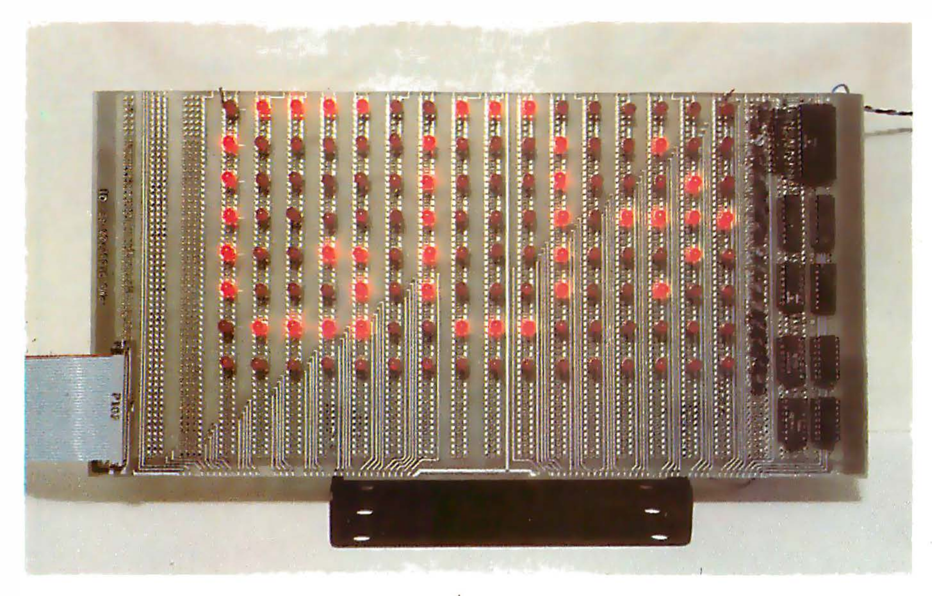


Photo 2: The prototype board displaying GO→ without a red filter in front of the LEDs.

that they are open collector devices readily allows this.

The second concern is lamp brightness. LEDs operated at low currents can have widely varying brightness. It is a good idea to pretest and select LEDs which appear to have the same intensity at a specific current.

Build a Self-Refreshing LED Display

So far I've discussed arrays which, because of their size, have limited appeal and application. A 4 by 4 display is still in the realm of indicator, rather than information display panel. To be really effective it should at least be able to display an alphanumeric character. Such a requirement dictates a minimum matrix size of 5 by 7. This adequately displays all upper-case letters and numbers. But if you are going to have 5 by 7, why not 10 by 7 for 2 letters and so on?

At some point we have to be rational. If it were that easy to make 200 by 200 LED arrays, someone would be making them now. In my case I needed a multipurpose flat panel display that could flash a message (even if only 1 letter at a time) and serve as a sophisticated annunciator for my alarm system. The latter was the true reason for the use of LEDs.

A transparent sheet with an outline of my security system is placed over the LED array. Significant information is indicated by flashing the LED at the point within the array that corresponds to appropriate sensor activation. It is quite interesting to watch the approach of a car down the driveway as a series of LED indicators track it.

A 4 by 4 display was too low in resolution, and while a 5 by 7 display allowed ASCII alphanumeric displays, it was also a bit limited. Considering the hardware techniques employed and relative indifference to refresh considerations, I settled on an 8 by 16 display.

Photos 1 and 2 show the completed display prototype. The prototype consists of 128 red LEDs arranged in 16 columns of 8. Photo 1 illustrates them all lit. A red plastic filter is used to enhance the display. Photo 2 shows it without the filter.

The schematic diagram for this interface is outlined in figure 5. As with the majority of my designs, I've made this to be processor, and program execution-speed independent. It works equally well with assembly language or BASIC systems, provided that a program can directly address output ports. The interface is a stand-alone peripheral. Once loaded with display data, refresh operation is locally controlled, and the computer can even be shut off without disturbing the display.

Self-Refreshing—How Does It Work?

There are 3 major hardware subsystems in the 10-chip circuit: input decoding, data storage, and refresh scanning. To the computer, this interface appears as 16 output port addresses numbered 112 thru 127 decimal (remember BASIC uses decimal

Number	Type	+5 V	GND
IC1	7430	14	7
IC2	7404	14	7
IC3	74121	14	7
IC4	7489	16	8
IC5	7489	16	8
IC6	7406	14	7
IC7	7406	14	7
IC8	74157	16	8
IC9	7493	5	10
IC10	74154	24	12

Table 1: Power-wiring table for figure 5.



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The Apple II's specs are tempting enough without the Language System and Pascal. With them, they're downright irresistible.

The text, normally displayed as 24 lines of 40 characters each, expands to 80 characters thanks to the use of horizontal scrolling.

Characters are normal, inverse or flashing, 5 x 7, upper case. Full cursor control is standard.

Since Pascal runs on an Apple computer with 48K bytes of on-board RAM, the additional 16K bytes on the language card bring the total to a full 64K bytes.

And, Pascal runs on the new Apple II Plus. It features an Auto-Start ROM that boots the Disk II at power-on for turn-key operation. Applesoft extended BASIC is resident in ROM.

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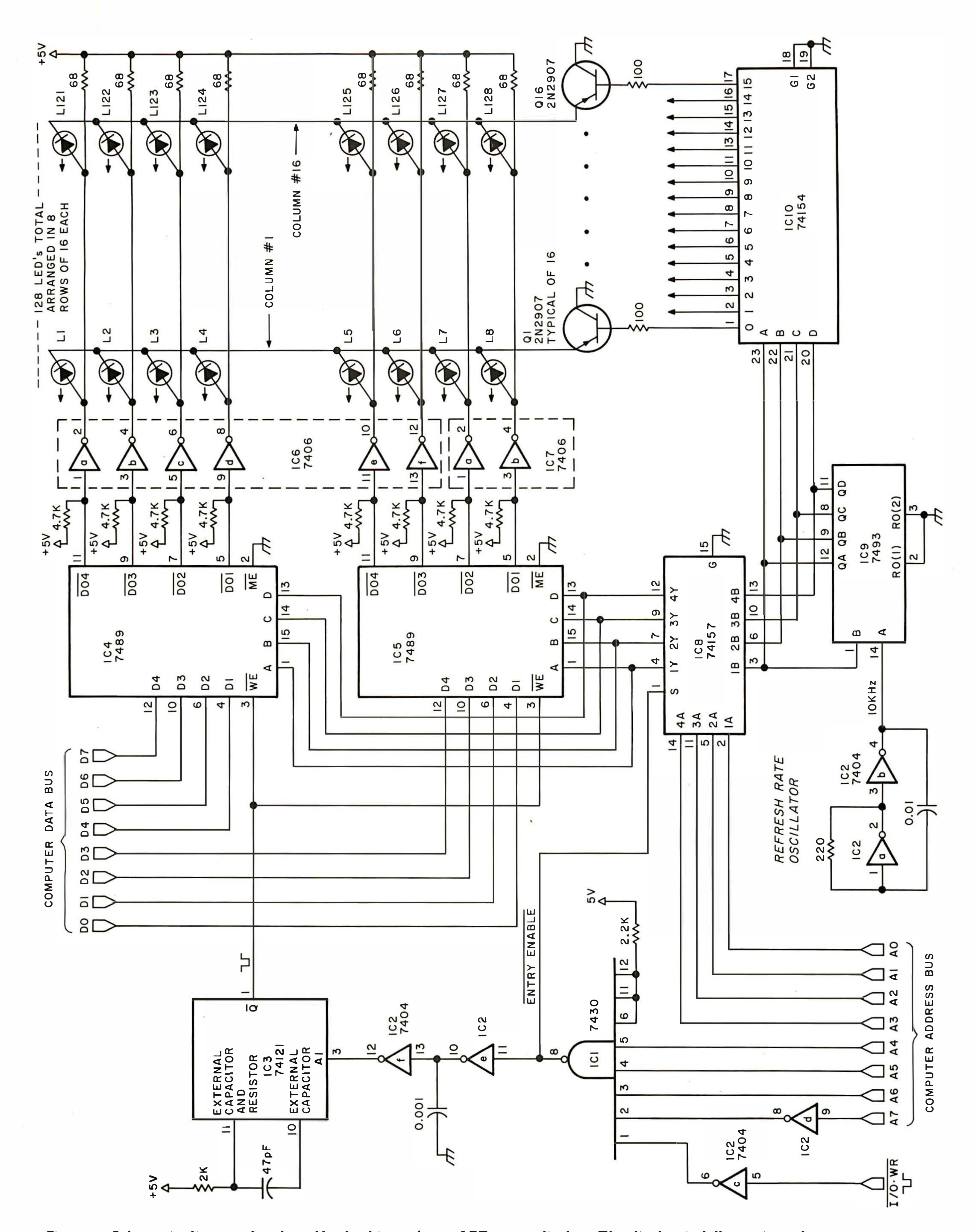


Figure 5: Schematic diagram for the self-refreshing 8 by 16 LED array display. The display is fully static and appears as 16 output ports to the computer. Note that the schematic diagram shows the use of 10 integrated circuits, while the prototype board only has 9 integrated circuits on it. The I/O decoding logic on the prototype system was not constructed on the board, but on the other end of the ribbon cable shown in the photographs.

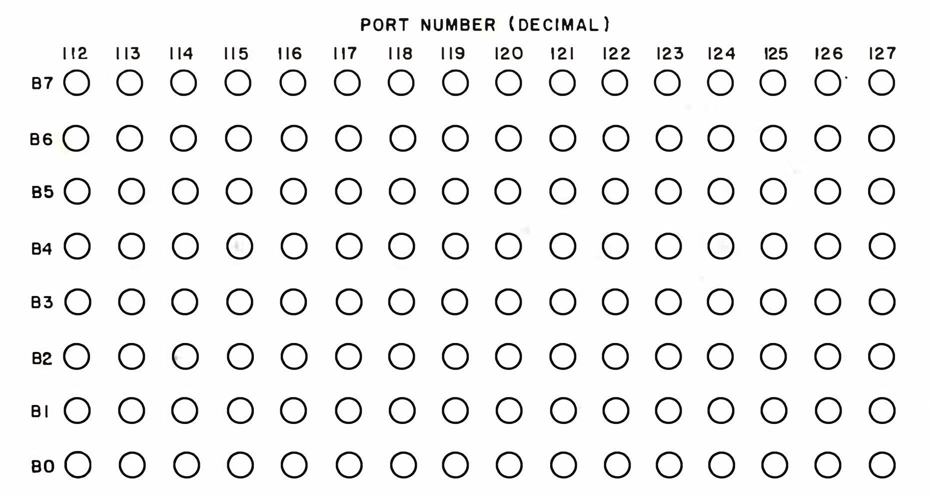


Figure 6: The 128 light emitting diodes (LEDs) are laid out in groups of 8. Each group of 8 is assigned to a consecutive output port. The port numbers are given here in decimal.

notation). Each column represents the 8 bits of that port.

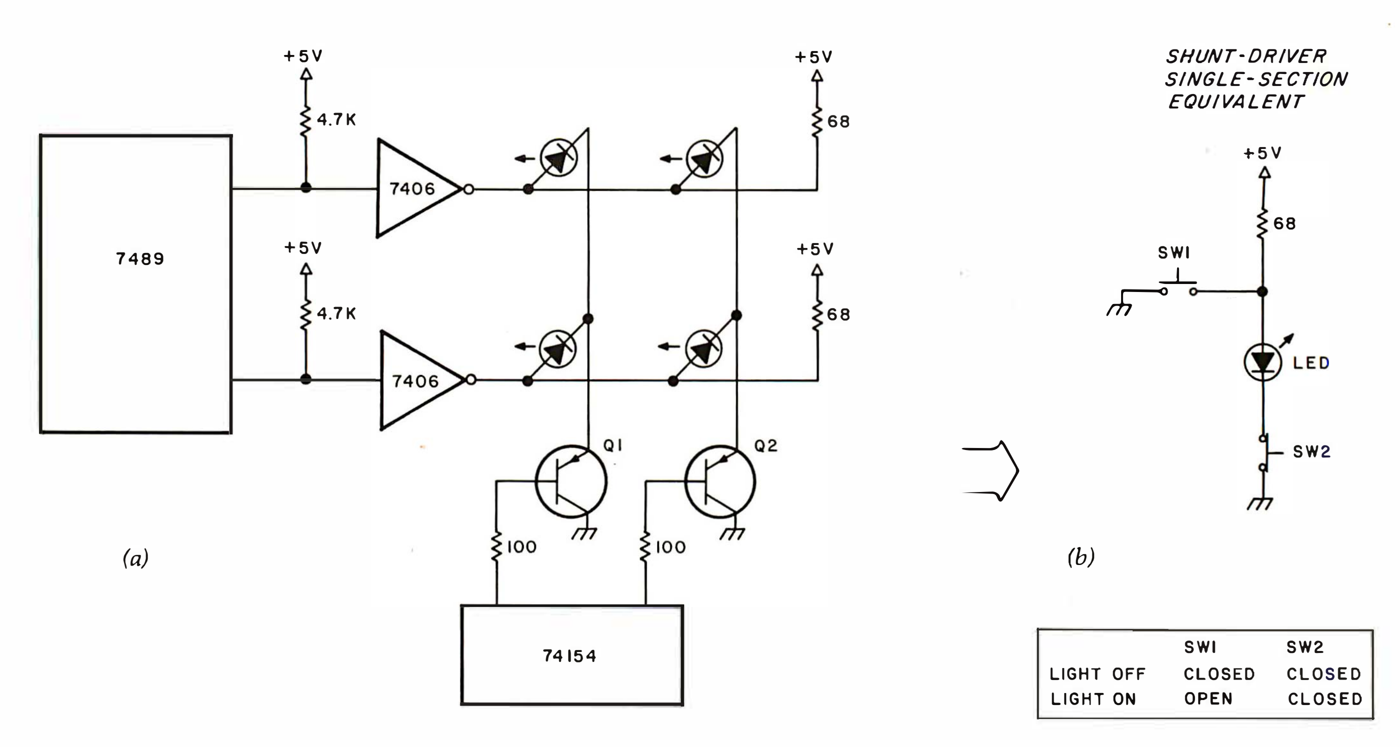
The most significant bit (MSB) is at the top and the least significant bit (LSB) is at the bottom. The leftmost column is decoded as port number 112 and the rightmost is port number 127. This is depicted in detail in figure 6. These selections are arbitrary and can be any 16 successive port addresses you have available. These ports can also be memory mapped to use PEEK and POKE instructions rather than input/output instructions, if you wish. (For further information on memory mapped I/O I refer you to the book *Ciarcia's Circuit Cellar* from BYTE Books.) ICs 1 and 2 decode these 16 addresses.

Integrated circuits IC3, IC4, IC5 and IC8 perform the data storage function. IC4 and IC5 are each 4-bit by 16-word programmable memory devices which together form an 8-bit by 16-word storage. When data is ready for display, the computer performs an output procedure to the selected port. The entry-enable line goes low, selecting address bus lines A0 thru A3 to be applied as the address inputs to the 2 memory devices.

If port decimal 115 were selected in BASIC, the binary address would be 0011. Sections c and d of IC2 are included to forestall a potential race condition and serve to delay the firing of the one-shot monostable multivibrator IC3 until the propagation delay of ICs 4, 5, and 8 is satisfied. Once this port address is set through the 74157, the one-shot fires and writes the data present on the data bus into the memory. This is essentially the same sequence as any latched output port with the exception that 16 data bytes can be stored.

The schematic diagram as shown uses transistor-transistor logic (TTL) devices. If you have an S-100 system, or otherwise have limited bus driving capabilities, you may want to substitute low power TTL devices where necessary, or buffer all incoming lines.

The final area of significance is the LED refresh scanner. Figure 7 provides an expanded illustration. Rather than successively addressing 128 LEDs, resulting in a very low-



	SW1	SW2
LIGHT OFF	CLOSED	CLOSED
LIGHT ON	OPEN	CLOSED

Figure 7: Expanded illustration of column scanning techniques used in self-refreshing LED graphics unit shown in figure 5. Each LED is not addressed sequentially; the LEDs are addressed by column. This results in a higher refresh rate and lower peak current to maintain a uniform brightness. For any particular LED to be turned on, the equivalent of 2 switches has to be closed (SW1 and SW2 in 7b). For this to happen in the circuit of figure 7a, the column must be addressed by the 74154, and then the coinciding byte of memory (7489) provides the other switch. The LED is lit when the correct row is addressed and the corresponding bit is set to 1.

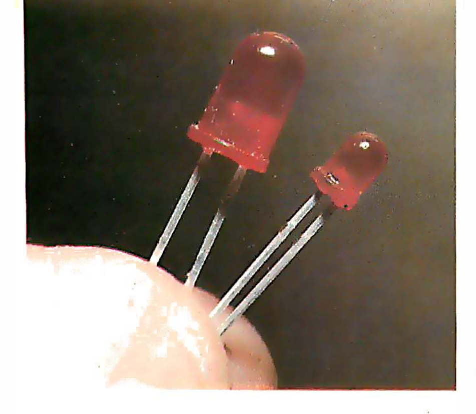


Photo 3: *Two of the more popular red LEDs are the TIL-209 (the smaller LED) and the TIL-220 (larger LED). The average price for these devices is $0.09 and $0.11 apiece in quantity.*

duty cycle, this design incorporates column scanning. Each light emitting diode (LED) is refreshed once every 16 clock pulses, rather than once every 128. The result is that lower peak current is required to maintain sufficient illumination.

When no data is being written into the memory (ICs 4 and 5), the address multiplexer is in the display mode. In this case it continually channels the output of a 4-bit free-running counter (IC9) to the memory address input. IC10 also receives this address and enables the particular column to which the data pertains.

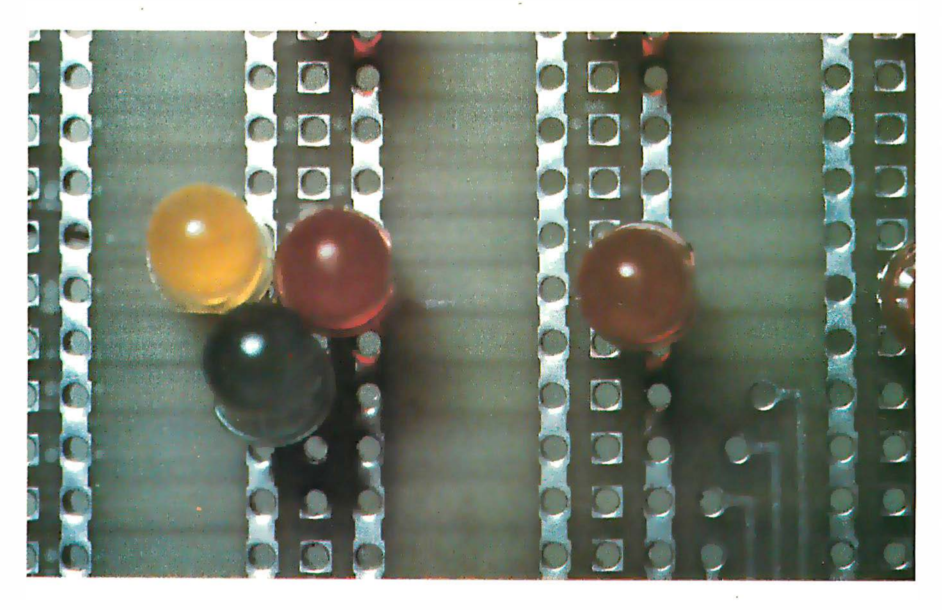


Photo 4: To experiment with 3-color displays, 3 LEDs must be placed in each position on the board.

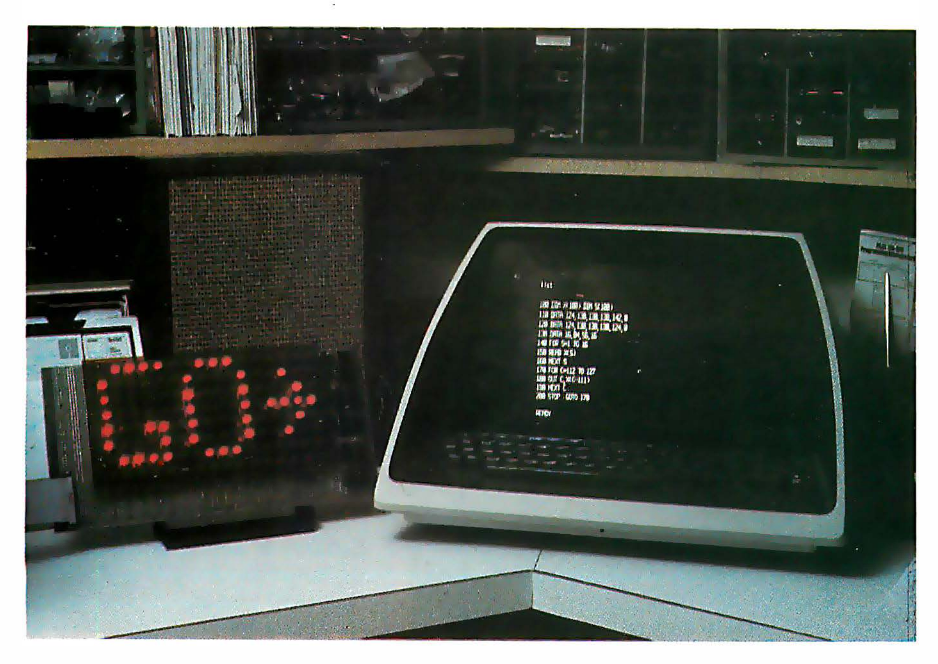


Photo 5: The program in listing 2 produces the display shown here.

In a normal sequence, the first address is 0000 binary. Since the memory is in a read condition, the output will reflect the data contents which had been stored previously as an output to port 112. IC10, a 4 to 16 demultiplexer, enables the first line by bringing it to a logic 0. The shunt drivers now enabled will allow any LED in that column to turn on in response to a stored logic 1 on that bit position. The only LEDs that can light at this time are in the first column.

The circuit will stay on this address until the next clock pulse from ICs 2a and 2b. The next address would enable the next column with similar results. The scan oscillator should be fast enough that the display does not flicker.

Various LEDs can be used. Probably the most popular size is the T-1¾ (such as the Texas Instruments TIL-220) made by most LED manufacturers and priced at about $0.11. If space is a problem, a smaller T-1 can be used with cost at about $0.09. Their relative sizes are shown in photo 3.

There is nothing which requires that the display be monochromatic. Considering that color television screens are actually discrete dots which seem to blend together when viewed from a distance, this same possibility is open for use with LEDs to a limited extent. The 3 LEDs can be mounted quite closely as demonstrated in photo 4. Experimenting with the tricolor system produced some interesting results. You must realize, of course, that a 3-color display would require 3 sets of digital logic equivalent to the circuit of figure 5.

Using a Flat Panel Display

The first thing to do after powering up and checking out the circuitry is to try to write data to it. Listing 1 is a BASIC program which sequentially exercises all 128 LEDs. Erroneous data entry can usually be traced to a too long pulse width on the one-shot (IC3).

Once the arrays have been built, you are ready for the big time— displaying a 5 by 7 dot-matrix character. Photo 5 illustrates this final achievement, and listing 2 shows the simple BASIC program required to accomplish this.

Listing 1: BASIC program to turn each light emitting diode (LED) on and off in order.

```
100 REM THIS PROGRAM CHECKS EVERY LED INDIVIDUALLY
110 REM BY OUTPUTING A SERIES OF COMPUTED VALUES TO THE
120 REM APPROPRIATE OUTPUT PORT
130 REM
140 REM 8X16 DISPLAY IS ADDRESSED AS 16 PORTS - NO.S  112 TO 127 DECIMAL
150 REM WITH LSD ON THE LEFT AND MSD ON THE RIGHT
160 REM
170 REM FIRST THE DISPLAY IS  BLANKED BY OUTPUTING ALL ZEROS
180 FOR S=112 TO 127
190 OUT S,0
200 NEXT S
210 REM
220 REM STARTING FROM THE LOWER LEFT CORNER LEDS ARE PROGRESSIVELY LIT
230 REM UP AND DOWN THE COLUMNS MOVING TOWARD THE RIGHT
240 FOR I=112 TO 127
250 FOR B=0 TO 7
260 A=2^B
270 OUT I,A
280 GOSUB 1000
290 NEXT B
300 OUT I,0
310 NEXT I
320 GOTO 240
1000 FOR T=0 TO 50
1010 NEXT T
1020 RETURN
```

Listing 2: BASIC program to write GO→ on the LED display.

```
100 REM THIS PROGRAM WRITES GO > ON THE DISPLAY
110 REM USING DATA STATEMENTS TO ENTER MATRIX DATA
120 DIM X(100):DIM S(100)
130 DATA 124,130,130,138,142,0
140 DATA 124,130,130,130,124,0
150 DATA 16,84,56,16
160 FOR S=1 TO 16
170 READ X(S)
180 NEXT S
190 FOR C=112 TO 127
200 OUT C,X(C-111)
210 NEXT C
220 STOP :GOTO 190
```

Static displays are interesting, but if you really want to do a little crowd-pleasing, then I suggest simulating a moving marquee. Because this display interface is column-oriented, it is relatively simple to accomplish this feat. Listing 3 is a program for shifting the letter A across the display.

The character is left-justified when first displayed with the 5 by 7 data written in ports 112 thru 116. On the next programmed update, the same data is written to ports 113 thru 117,

Listing 3: BASIC program to move the letter A across the display from left to right.

```
100 REM THIS PROGRAM DEMONSTRATES USING THE DISPLAY PANEL AS A MOVING MARQUEE
110 REM A 5X7 DOT MATRIX LETTER A IS DISPLAYED ON THE LEFT SIDE
120 REM AND THE SHIFTED ACROSS THE DISPLAY TO THE RIGHT. USING THIS CONCEPT
130 REM VIRTUALLY ANY MESSAGE CAN BE WRITTEN.
140 DIM A(100) :DIM S(20) :DIM X(100)
150 REM FIRST THE LETTER A IS LEFT JUSTIFIED ON THE DISPLAY
160 A(1)=254 :A(2)=144 :A(3)=144 :A(4)=144 :A(5)=254 :REM A(1)-A(5) EQUAL THE LETTER A
170 FOR Q=6 TO 20 :A(Q)=0 :NEXT Q
180 REM
190 REM
200 REM CLEAR THE DISPLAY
210 FOR L=112 TO 127 :OUT L,0 :NEXT L
220 REM
230 REM
240 REM DEFINE TRANSPOSED MATRIX X(1) TO X(16) AND SHIFT RIGHT ONE COLUMN
250 S=1
260 FOR D=1 TO 16
270 X(D)=A(S)
280 S=S+1
290 IF S>20 THEN S=1
300 NEXT D
310 S=S+3
320 GOSUB 370
330 GOTO 260
340 REM
350 REM
360 REM WRITE TRANSPOSED MATRIX TO DISPLAY
370 FOR L=112 TO 127
380 OUT L,X(L-111)
390 NEXT L
400 FOR T=0 TO 300 :NEXT T :RETURN
410 RETURN
```

effectively shifting it to the right by 1 column. For long messages, the most effective method is to utilize a software pointer. Even a 2⅔ character moving marquee is very impressive and can easily convey intelligent information.

This 8 by 16 matrix can be expanded by adding more memory and column decoders. It can be further enhanced by the addition of other colors within the same array.

The video screen need not be the only output display on a personal computer. It is only a matter of time before large arrays are commercially available, but in the meantime we can experiment with the concept. I hope that by presenting a self-refreshing interface design which eliminates the necessity of interrupts or dedicated program refresh, I may spark the interest of many experimenters.

If you have any questions on this or any previous article, don't hesitate to write to me. Please include a self-addressed stamped envelope. ■

Next Month: A look at the new Intel 8086.

Technical Forum

Using Finite State Machines

David E Cortesi, 2340 Tasso St, Palo Alto CA 94301

I was pleased to see a good introductory article on the use of finite state machines appear in BYTE (see "Designing a Command Language" by G A Van den Bout, BYTE, June 1979, page 176). I have found the finite state machine (or finite state automaton, or just FSA) to be a valuable tool in my programmer's toolkit. The finite state machine is an aid to organizing one's thoughts while designing, a good way of producing a really unambiguous specification document, and as an implemented program it can yield very efficient and reliable code.

The finite state machine has long been a plaything of the theoreticians of computer science; you can find it described and analyzed in any textbook on compiler design (it is a *good* textbook if you can understand the description!). Unfortunately the finite state machine rarely moves out of the textbook and into practical programs. I would like to extend Van den Bout's article with 2 examples from my own experience as a professional programmer that show how the finite state machine solved difficult programming problems in the real world.

The first case arose during the design of a timesharing system that was to have a large number of commands. The syntax of the command language was laid down early in the project, but the specification of the commands themselves kept changing. If I and my colleagues had tried to write detailed code to parse each of the many commands and operands, especially in the face of changing specifications, we would have been swamped. We had to do something to systematize the command-parsing code.

We hit on the idea of using finite state machines represented as directed graphs (like the figures in the previous BYTE article). Since we were using a macroassembler, we created NODE and ARC macroinstructions so that we could "draw" the graph of a command by writing a series of macro calls. Listing 1 shows how some of the chess game commands in the prior article might look in such a macrolanguage.

Each macroinstruction assembled to a small group of constants. We thought of these groups as the machine language of an imaginary finite state computer. We then wrote a finite state interpreter which could process these machine instructions. This interpreter program took as its input: (1) the top node of a graph; (2) the tokenized command line from the user; and (3) a small working storage area where semantic routines could leave their

```
S1    ANODE                 ; TOP NODE, ARCS SELECT VERB-TOKENS
      ARC    TOKEN=KWD,VALUE='MOVE',NEXT=S2M
      ARC    TOKEN=KWD,VALUE='CAP',NEXT=S2C
      ARC    TOKEN=KWD,VALUE='TAKE',NEXT=S11
      ZNODE 'MOVE, CAP, OR TAKE??'
S2M   ANODE VERB=1          ; SET VERB-CODE OF MOVE
      ARC    TOKEN=ANY,NEXT=S2
S2C   ANODE VERB=2          ; SET VERB-CODE OF CAP
                            ; COMMON GRAPH FOR MOVE AND CAP
S2    ANODE
      ARC    TOKEN=KWD,VALUE='FROM',NEXT= S3
      ARC    TOKEN=KWD,VALUE='TO',NEXT=S8
      ZNODE '?? PLEASE SAY TO OR FROM'
                              ; GRAPH OF 'FROM XX TO YY' PART
S3    ANODE
      ARC    TOKEN=POS,SEMACT=FRPOS,NEXT=S4
      ZNODE 'A POSITION MUST FOLLOW FROM'
S4    ANODE
      ARC    TOKEN=KWD,VALUE='TO',NEXT=S5
      ZNODE 'FROM XX -- EXPECTING TO'
S5    ANODE
      ARC    TOKEN=POS,SEMACT=TOPOS,NEXT=S6
      ZNODE 'A POSITION MUST FOLLOW TO'
                              ; GRAPH OF 'TO XX FROM YY' VARIANT
S8    ANODE
      ARC    TOKEN=POS,SEMACT=TOPOS,NEXT=S9
      ZNODE 'A POSITION MUST FOLLOW TO'
S9    ANODE
      ARC    TOKEN=KWD,VALUE='FROM',NEXT=S10
      ZNODE 'TO XX -- EXPECTING FROM'
S10   ANODE
      ARC    TOKEN=POS,SEMACT=FRPOS,NEXT=S6
      ZNODE 'A POSITION MUST FOLLOW FROM'
                            ; END-CHECK FOR MOVE AND CAP
S6    ANODE
      ARC    TOKEN=END      ; OMITTED NEXT= MEANS 'ALL DONE'
      ZNODE 'EXTRA OPERAND'
S11   ANODE VERB=3          ; SET VERB-CODE OF TAKE

  ... etc, etc, etc.
```

Listing 1: A graph representation of a finite state machine as it might look drawn with a macroassembler. The macroinstructions would assemble to machine language for a hypothetical finite state computer; that in turn would be simulated by an interpreter.

ROW	INPUT TOKEN +	-	0	1...9	.	E	<end>
1	2/A0	2/A1	3/A0	4/A2	5/A3	0/E1	0/E2
2	0/E3	0/E3	3/A0	4/A2	5/A3	0/E4	0/E5
3	0/E6	0/E6	3/A0	4/A2	5/A3	6/A4	0/Z1
4	0/E7	0/E7	4/A2	4/A2	5/A3	6/A4	0/Z2
5	0/E8	0/E8	5/A5	5/A5	0/E9	6/A4	0/Z3
6	7/A0	7/A6	7/A0	7/A7	0/E10	0/E11	0/E12
7	0/E13	0/E13	7/A7	7/A7	0/E10	0/E11	0/Z4

```
A0: do nothing                    Z1: exit, value is zero
A1: note negative                 Z2: exit, value is integral
A2: collect integer digit         Z3: exit for rational
A3: note rational                 Z4: exit for exponential
A4: note exponential
A5: collect fraction digit
A6: note negative exponent
A7: collect exponent digit

E1: number(?) is <E>..            E8:  ..<decimal><sign>..
E2: number is null                E9:  ..<decimal><decimal>..
E3: <sign><sign>...               E10: ..<E><decimal>..
E4: <sign><E>..                   E11: ..<E><E>..
E5: <sign><end>                   E12: ..<e><end>
E6: 0..<sign>..                   E13: ..<E><sign><sign>..
E7: <digit>..<sign>..
```

Table 1: A finite state machine for processing numeric constants, represented as an array. Each row is a state of the machine; a column is selected by the next input token. At the intersection is the row number for the next step, and the name of an action to be done.

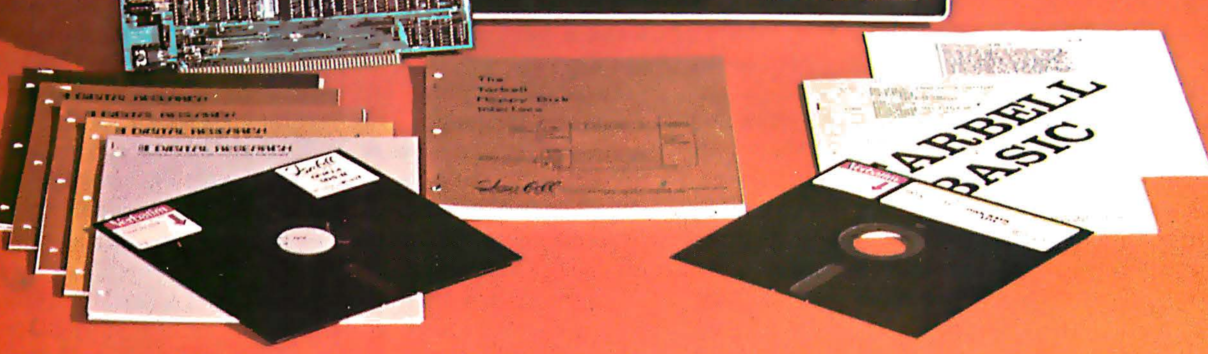
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output. It returned either a verb number (from an ANODE macroinstruction) or an error message (from a ZNODE macroinstruction). The only other code needed was a set of small, easily coded semantic routines, one to convert and store away each kind of token.

With this mechanism in place we had only to "draw" each command's graph in macroinstructions, and add any semantic routines unique to that command. The job was much smaller than writing code for all commands, and far easier to update as the specifications fluctuated. The same interpreter was used again in a later project with a similar command language.

This method of writing a command language turned out to have an advantage we had not expected. Every time we wrote a ZNODE macroinstruction, we were faced with the fact that someday a user would enter a bad command that would drop through to that ZNODE. Each time we were forced to decide what the system should do when that occurred. Every possible user error was made evident to us and we had to think about error responses in more detail than usual, but the very specific circumstances under which each error was trapped made it easy to give explicit, helpful messages.

The second example comes from the construction of an interpreter for a programming language. An interpreter has to do a lot of converting between the character form of numbers and their internal form (binary, in this case). The language being implemented supported every form of numeric constant, including things like

1. (for a real 1.0)
3E25 (decimal not required)
+00319645.26E-0005 (leading zeroes, signs)

When I was presented with this problem I had just completed a course in compiler writing, where I had seen finite state machines applied to exactly this problem. It took but a day to work out an array like that in table 1. This is a finite state machine, but one represented as an array instead of a graph. The 2 representations are equivalent; a finite state machine drawn as a graph can be drawn as an array or vice versa. The nodes of the graph become the rows of the array; the lines become columns.

The array is processed like this: the finite state machine is always active on some row, initially row 1. Get the next input token. Find the column with that token at its head (of course a clever designer will have arranged that a token is just an integer that is a valid column-index). At the intersection of that column and the active row, find 2 items, such as 2/A1. The first item, like 2, becomes the new active row. The second item, like A1, is the label of a semantic action to be performed. Repeat until the active row number is 0, then stop.

Look at row 1 of table 1. Reading across, if the first token of a numeric constant is:

+ do nothing and go to row 2
− remember to negate the result and go to row 2
0 do nothing and go to row 3
1...9 collect a digit and go to row 4
. note the number will be rational ("real") and go to row 5
E error — number starts with E, stop
<end> error, stop

If you read the other rows the same way, you will see how this finite state machine can parse any legitimate numeric constant. It also finds every possible syntax error in a very explicit way.

So far I had not gone beyond what any textbook could tell me, but I had the additional objective of making the fastest assembler language constant converter that I could. I wanted to use every hardware advantage allowed by my machine, yet keep reliable, readable code — and the finite state machine helped me!

I eventually ended up with an array several rows higher than the one in table 1. Each additional row was designed to pick up a particular set of input characteristics that I could take advantage of. One optimization was row 3 of table 1, which does not appear in most textbooks. The finite state machine stays on row 3 as long as it is seeing leading zeroes on the integer part of the number. Action A2, "collect integer digit," will typically involve performing arithmetic operations on the token. A leading zero contributes nothing to the final binary value, so why "collect" it? The finite state machine stays on row 3, spinning through the leading zeroes and doing almost no work, until a significant digit is found. If the finite state machine takes exit action Z1, it has recognized a constant of zero (fairly common in programs) without doing any arithmetic.

We expected single-digit constants to be quite common in typical programs. It happened that the binary value of a single digit could be obtained from the input token with a logical AND operation. I put in another row between rows 3 and 4 of table 1, so that a special exit action would be taken for the case of <digit> <end>. Now the finite state machine would process any single-digit constant without doing arithmetic. These and other hardware-level optimizations were achieved during design; they added almost nothing to the complexity of the final code.

The array form of a finite state machine is easily coded using a pair of integer matrices, one for the next-state numbers and one for the action-numbers (action-labels, if your language allows label variables; action-addresses in assembler language). The resulting program almost has to be smaller and more readable than the brute force code needed to do the same job. Since the act of designing the array forces you to consider every possible input sequence, the program will usually be much more reliable.

I have drawn these examples from professional software projects, but those are certainly not the only places where finite state machines can be used. I hope I have shown that the finite state machine can be a valuable tool for anyone faced with programming for a complicated input string. Designing it clarifies the problem and reveals all error situations, and coding it yields elegant, efficient programs.■

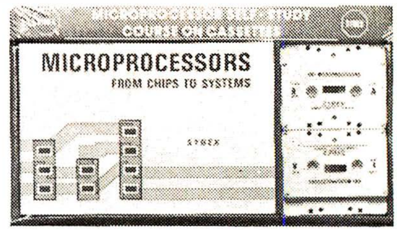
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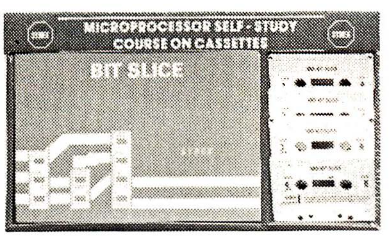

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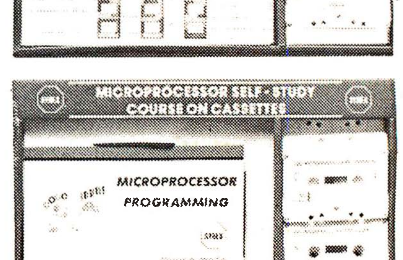
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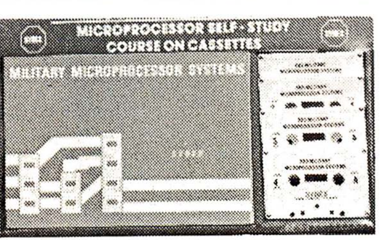
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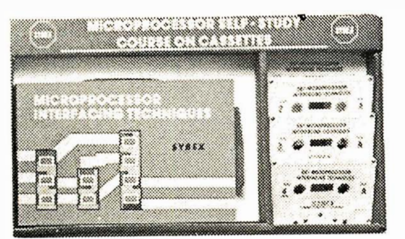
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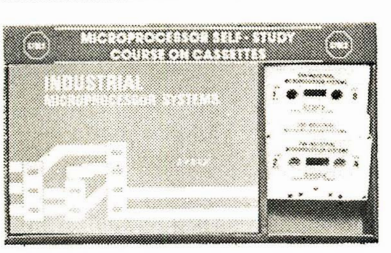
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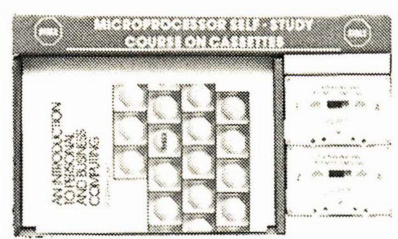
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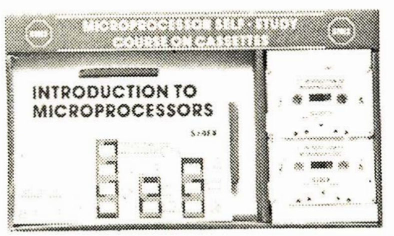
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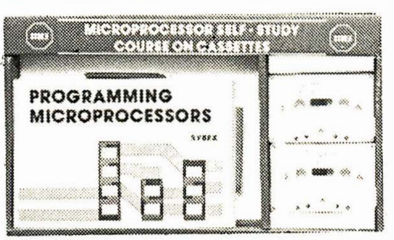


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Picking Up the Pieces

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Everything had been going so smoothly. I had just saved several important programs on a disk and had planned to spend the rest of the afternoon doing fun things with them. Now the computer was telling me that my full disk was completely empty.

I had been using my floppy disk system for over 6 months before the output error mentioned above occurred. I discovered, to my sorrow, that while input and output errors on a floppy disk are *very* rare, they can still happen. I survived my catastrophe. I hope that my experience can help you survive yours.

Disk Files

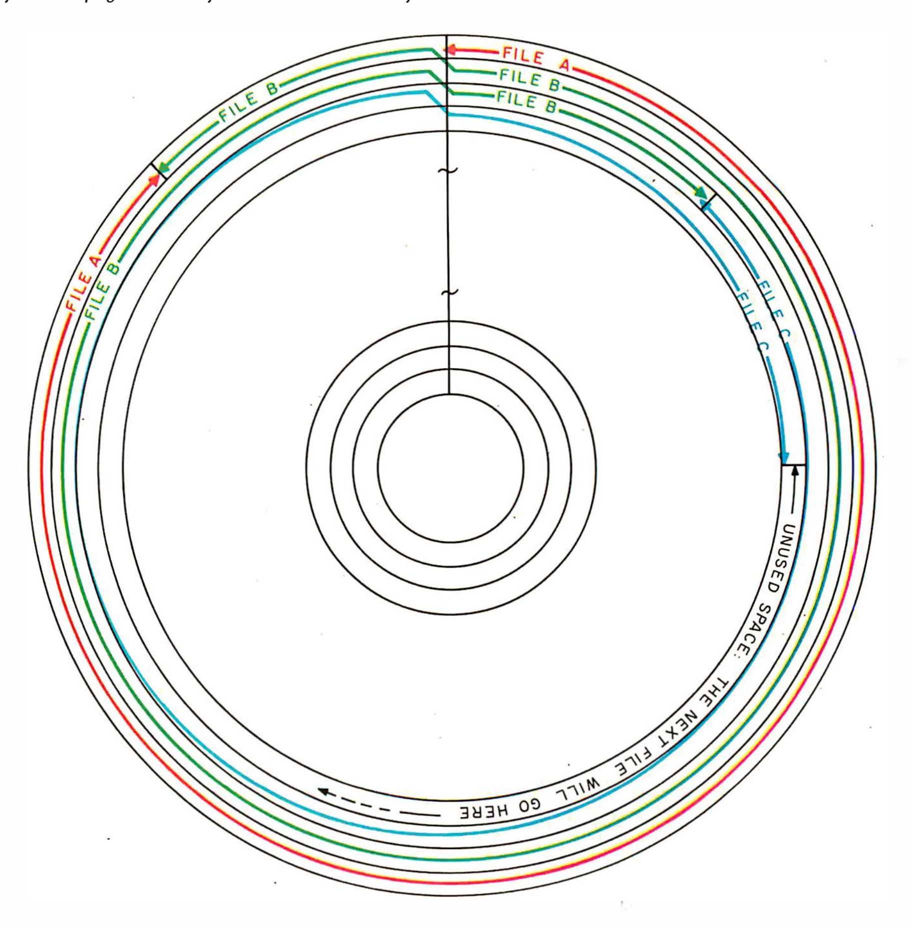
Generally, 2 different methods are used to place files on a floppy disk: sequential file storage, and track or sector allocation.

In the sequential file storage method, a new file is placed on the disk in the unused sectors following the last file added to the disk. This is demonstrated in figure 1. Any files that are deleted, such as file B, will generate unused space on the disk that is not used for storing new files. New files go at the end of all previously used space. But what about all of the unused space taken up by the deleted files? Simple. These systems provide a utility program which eliminates this unused space by shifting the files on the disk. This process, which is called *compressing or packing the disk*, is shown in figure 2.

If this is the way your system works, then the data block that got wiped out on my system exists on your system. However, as you will see, its contents and use are totally different.

The track, or sector allocation method is also known as the bit map method or chained, sequential-storage method. It is used by the more impressive, and efficient, large-system support packages. It is also used by my Peripheral Vision floppy disk operating system (FDOS).

Figure 1: In the sequential storage method, files are placed on the disk starting at the first empty sector after the last stored file.



About the Author

Al Baker is 30 years old and lives with his wife, Janet, and 2 children in Wheaton IL. He is currently the programming director for The Image Producers Inc, Northbrook IL. He is a member of the American Association for the Advancement of Science, the National Space Institute, and the Chicago Area Computer Hobbyist Exchange. He says, "My favorite sports are volleyball and handball, and my hobbies are playing with computers, photography, and playing with computers."

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In this method all of the space on the disk is represented by a single bit map. Each bit in the area called the bit map represents 1 physical area on the disk. In my system this area is a sector. (Refer to figure 3.) On each floppy disk there are 74 tracks represented in the bit map for that disk. (There are actually 77 tracks on the floppy disk, but the first 2 tracks contain the operating system, and the third functions as the directory, containing the bit map itself and the names and addresses of all the files on the disk. Since each track has 16 sectors when using FDOS, the bit map contains 74 times 16, or 1184 bits. This represents 1 bit for each sector on the disk. Dividing by 8 gives a bit map size of 148 bytes. This fits easily into a single 256-byte sector on the disk.

Now we can use the bit map to determine which sectors on the disk are in use. A file program will read the bit map into memory and will find a 0 bit in the map. The sector represented by this bit is unused. If a new file is being created and it needs another sector, FDOS turns the bit on (makes it a logic 1) and writes the bit map back onto the disk. When a file is deleted, the bits representing each sector in the file are turned off. The space is immediately available for use by another file. Now we have a way of using space on the disk which eliminates the problem of wasted space caused by the old way of doing things.

Unfortunately this method creates its own set of problems. The first problem is not very obvious. If a file is longer than 1 sector, it won't fit. The wrong solution is to try to find an area with enough empty sectors located adjacently. We might as well consider all of those areas with just a few free sectors as useless space. Also, we never know how big a file is going to be until it is too late to look for a bigger space.

The correct solution is to let each sector in the file *point* to the location of the next sector in the file. Look at figure 4. Here we have a 1000-byte file of data contained on four 256-byte sectors. When a program tries to read the 257th byte from the

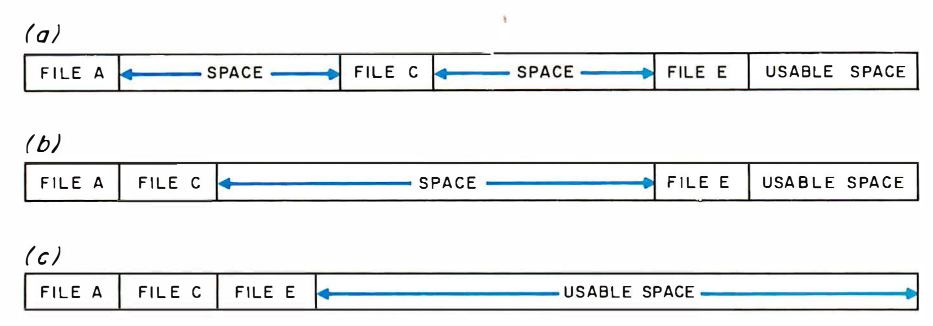


Figure 2: In a system which uses the sequential storage method, unusable space is turned into usable space by compressing the data. Starting with the data stored on the disk (2a), the usable data is shifted toward the beginning of the storage space until the files are behind each other (2b). This process is continued until all of the unusable space has been pushed to the end of the disk and is usable.

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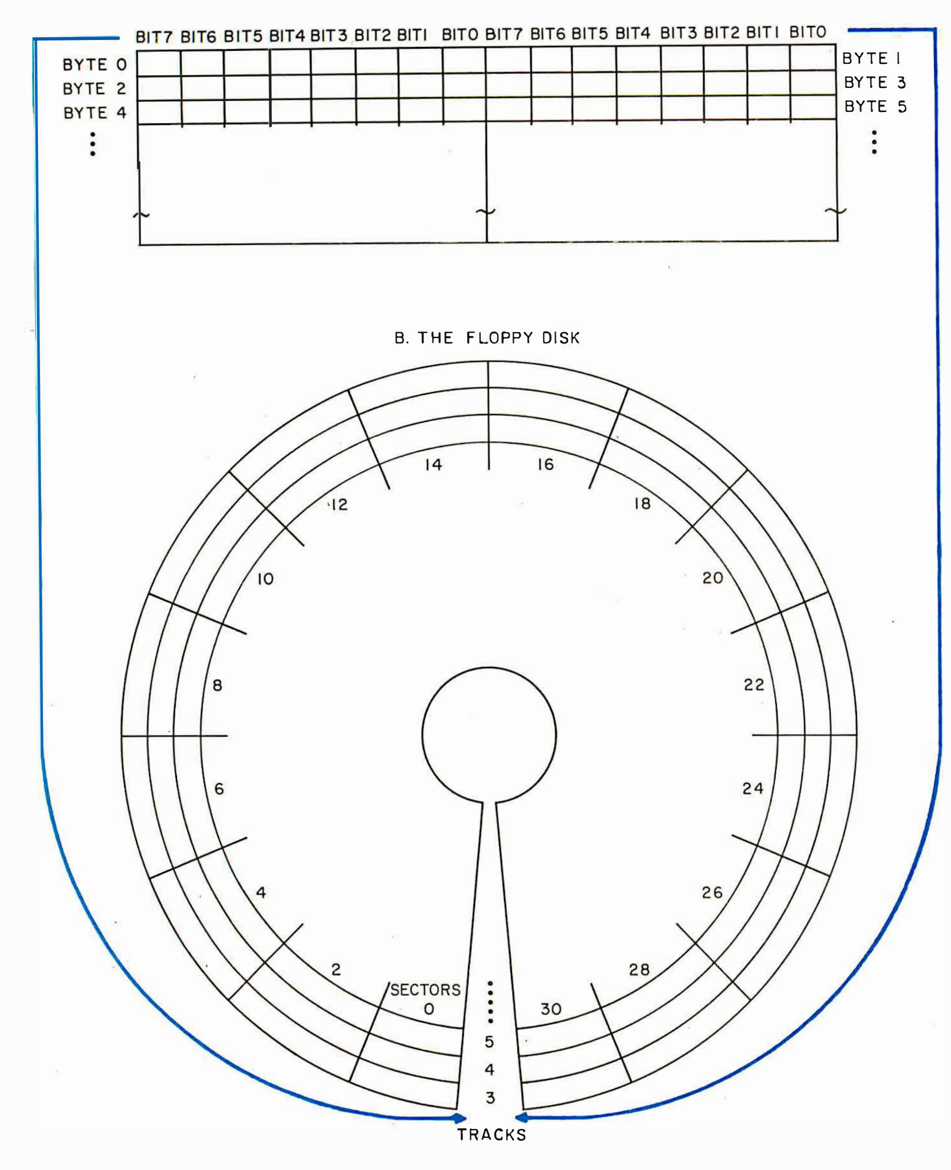


Figure 3: In the Peripheral Vision FDOS system, each sector is represented by 1 bit in the map (3a). If the bit is on (logical 1), then that sector is being used; if the bit is off, that sector is free space (3b).

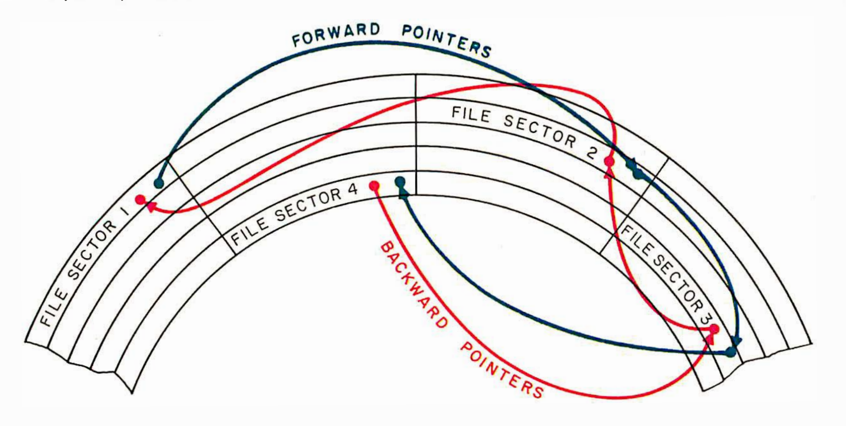


Figure 4: When a file is too long for one sector, it must be broken into several sections. Often, there are not enough contiguous sectors to contain a file. One method of solving this problem is to have bytes in the sector point to the location of the next sector. The FDOS system also has a backward pointer so 2 bytes are used.

file, FDOS automatically follows the pointer (contained in the first sector of the file) to the second sector, retrieves the first byte of that sector, and returns it to the user program. FDOS also keeps backward pointers, so you can read the file backwards, too!

The second problem is that the bit map is the most important block of data on the disk. If something happens to it, every other file space on the disk is up for grabs.

ANALIZ

One becomes accustomed to the way that machines sound in operation. I had just saved a file on disk, and it didn't sound right. Since the disk was nearly full, most of the empty sectors were far from the bit map. I had become accustomed to hearing the disk drive data transfer head make a particular sound as it moved from the bit map to the next empty sector and back to the bit map as new files were written out. The sound was missing!

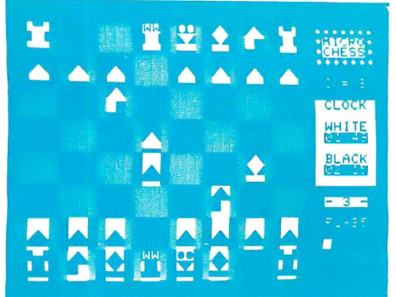
I knew that something was wrong. I quickly checked the number of free sectors on the disk. The correct number should have been around 300. The answer that I got from my inquiry was 1100. Except for the file I had just written, the bit map said that I had an empty disk!

It was time for careful thought. I listed the directory: it still thought I had over 50 files on the disk. But I knew that some of those files had been destroyed, completely or partially, by the file I had just written on the disk.

I was left with 2 problems. First, I had to correct the bit map. The best way to do this was to read every sector for every file listed in the directory. As each sector was read, I could turn on its bit in the bit map. This would correct the first problem.

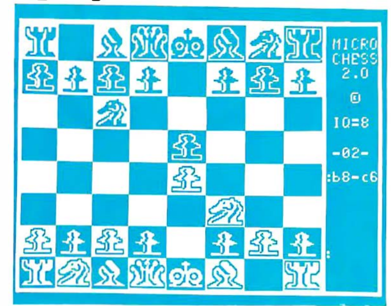
The second problem was more serious. I had to determine which files were destroyed. The file I had just written had almost certainly used sectors which had been part of good files. Fortunately, FDOS keeps 2-way pointers. The solution was simple. While solving the first problem, I had to read every file on the directory and check to see if each sector in a file pointed back to the previous sector. If it did not, then this sector no longer

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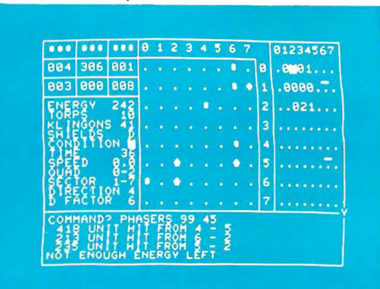


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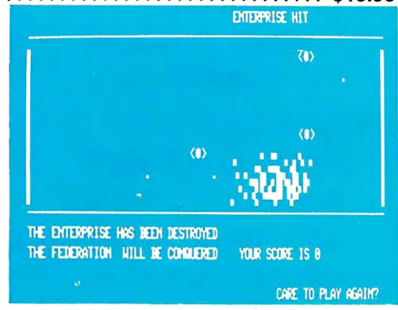


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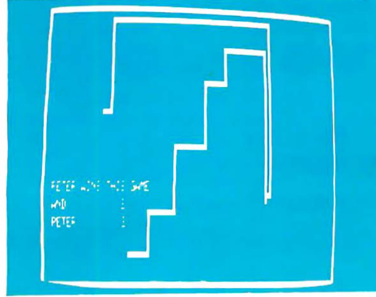


TIME TREK

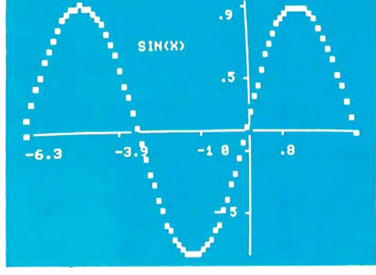
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belonged to this file. The file had been destroyed.

Now I was ready to make repairs. Very quickly, I wrote program ANALIZ (listing 1). Since I was in a hurry and wanted the program to run with no errors as soon as possible, I used structured programming techniques. Structured programming usually leads to a much shorter programming time if you include time spent debugging the code.

I'm not going to spend time telling you how the program works. Hopefully this has been accomplished with the comments in the listing. As I have said, the program is highly structured and should be easy to understand.

Conclusion

If you have Peripheral Vision FDOS, you can use the program as it is. If you have another bit-mapped disk system, then it should be a fairly straightforward matter to tailor it to your needs. If you have the sequential file storage method, then you have your own set of problems.

One final comment. Six files were destroyed on my disk. All of these files existed on the backup copy of the disk I had taken 2 weeks earlier. It is a *very good idea* to make periodic backup copies of your active disks. My only loss was a little time. I gained a better understanding of the way my disk system works, and a very interesting program.

Listing 1: Program ANALIZ is used to rebuild a bit map of the used sectors on a disk. This program is written using the TDL Z80 Relocating Assembler version 1.2. The workings of the program are explained in the comments.

```
.TITLE ' ANALYZE DISK AND FIX BITMAP'
.SBTTL ' .                    BY: A  BAKER'
;
;THIS IS THE MAIN ROUTINE FOR THE DISK
;ANALYSIS PROGRAM.  THIS PROGRAM TELLS
;THE USER WHICH FILES ON THE DISK HAVE
;CHAINING ERRORS.  IT DOES THIS IN TWO
;WAYS.  IT SIGNALS THE USER IF A CHAINED
;BLOCK DOES NOT POINT BACK TO THE BLOCK
;IT IS CHAINED TO.  ALSO, IT TELLS THE
;USER IF A BLOCK DOES NOT CONTAIN A
;VALID COPY OF ITS OWN DISK ADDRESS.
;FINALLY, IF THE USER WANTS, IT WILL
;REWRITE THE DISK BITMAP.  SINCE IT
;BUILDS UP THE MAP FROM VALID FILES ON
;DISK, IT CORRECTLY REFLECTS THE DISK
;CONTENTS, EVEN IF IT DID NOT BEFORE.
;
;THE ROUTINE 'INIT' SETS UP EVERYTHING,
;'SET' DOES ALL THE WORK, AND 'END'
;CLEANS UP AND ENDS THE JOB.
0000'                  ANALIZ:
0000'  CD 000A'         CALL INIT
0003'  CD 00B3'         CALL SET
0006'  CD 0052'         CALL END
0009'  C9               RET
;             ;
;THIS ROUTINE FIRST ALLOWS THE USER
;A CHANCE TO REMOVE THE CURRENT DISK
;FROM DRIVE ZERO AND REPLACE IT WITH
;ANOTHER ONE. ;THIS IS DONE BY USING
;THE MESSAGE TYPING ROUTINE 'TXTYP'
;TO TYPE THE MESSAGE '..M1', AND
;RECEIVING THE REPLY VIA THE TWO
;ROUTINES 'TXTIN' AND 'TI'.
;IT LOADS THE BITMAP USING THE FDOS
;ROUTINE 'MAPIN' AND ZEROS IT.
;FINALLY, IT INITIALIZES THE NAME
;HOLDING AREA BY ENDING IT WITH A ZERO.
000A'                  INIT:
000A'  21 002A'         LXI H,..M1
000D'  CD D073          CALL TXTYP
0010'  CD D079          CALL TXTIN
0013'                  ..LP2:
0013'  CD D076          CALL TI
0016'  30FB       :     JRNC ..LP2
0018'  CD D686:         CALL MAPIN
001B'  21 DBAC          LXI H,BITMAP
001E'  0694             MVI B,148
0020'                  ..LP1:
0020'  3600             MVI M,0
0022'  23               INX H
0023'  10FB             DJNZ ..LP1
0025'  97               SUB A
0026'  32 01BE'         STA NAMEH+9
0029'  C9               RET
002A'                  ..M1:
002A'  4849542043   .ASCIZ 'HIT CR WHEN CO
RRECT DISK IS IN DRIVE 0:'
;
;THIS ROUTINE GETS CONTROL AFTER ALL
;THE WORK HAS BEEN DONE.  IT USES THE
;'TXTYP' ROUTINE TO ASK THE USER IF
;HE WANTS THE NEW BIT MAP PUT BACK
;ON DISK.  HIS REPLY IS PICKED UP BY
;THE ROUTINES 'TXTIN' AND 'TI'.  IF
;HE REPLIES YES, EITHER UPPER OR LOWER
;CASE.  THE BITMAP IS WRITTEN TO DISK
;USING THE FDOS ROUTINE 'MAPOT'.
0052'                  END:
0052'  21 006B'         LXI H,..M1
0055'  CD D073          CALL TXTYP
0058'  CD D079          CALL TXTIN
005B'                  ..LP1:
005B'  CD D076          CALL TI
005E'  F620             ORI 20H
0060'  FE79             CPI 'Y'
0062'  2803             JRZ ..LP2
0064'  18F5             JMPR ..LP1
0066'  C9               RET
0067'                  ..LP2:
0067'  CD D6AA          CALL MAPOT
006A'  C9               RET
006B'                  ..M1:
006B'  444F20594F   .ASCII 'DO YOU WANT TH
E BIT MAP REPLACED?'
008C'  0D               .BYTE 13
008D'  4245205645   .ASCIZ 'BE VEEERRY CAR
EFUL BEFORE SAYING YES: '
;
;THIS IS THE MAIN DRIVING ROUTINE FOR
;DOING ALL THE WORK.  BECAUSE OF A
;DECISION TO MINIMIZE MEMORY USE, THIS
;ROUTINE IS COMPLICATED BY A DOUBLE
;USE OF THE FDOS SYSTEM INPUT BUFFER.
;THE DIRECTORY ROUTINES, 'DIROPN' AND
;'DIRBLK' USE THIS BUFFER FOR READING
;AND MAINTAINING THE DIRECTORY AND
```

Listing 1 continued on page 84

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Listing 1 continued:

```
; I DECIDED TO USE IT TO READ THE BLOCKS
; FOR EACH FILE.  FOR THIS REASON, EACH
; TIME A VALID FILE NAME IS FOUND, THE
; BUFFER (WHICH CONTAINS A DIRECTORY
; BLOCK) IS SAVED IN THE AREA 'BUFFER'.
; AFTER 'FIXIT' IS CALLED TO PROCESS
; THE CURRENT FILE, IT IS MOVED BACK
; INTO THE FDOS BUFFER 'RDFLNM' BEFORE
; GETTING THE NEXT DIRECTORY BLOCK.
;
; 'SET' IS A GRAND LOOP WHICH READS
; DIRECTORY BLOCKS.  FIRST, THE DIRECTORY
; IS OPENED WITH A CALL TO FDOS AT
; 'DIROPN'.  THEN EACH DIRECTORY ENTRY IS
; PROCESSED IN THE LOOP '..L1'.  WHEN
; 'DIRBLK' IS CALLED TO GET THE NEXT
; DIRECTORY ENTRY, IT SETS THE
; CONDITION CODE TO ZERO IF THERE ARE
; NO MORE PRESENT.  'SET' ENDS ON THIS
; CONDITION: WE ARE THROUGH.  'DIRBLK'
; PLACES THE FIRST BYTE OF THE NAME
; OF THE FILE IN THE ACCUMULATOR.  IF IT
; IS 255 DECIMAL (ALL ONES BINARY), THIS
; IS AN UNUSED ENTRY AND IS NOT TO BE
; PROCESSED.  IF IT IS TO BE PROCESSED,
; 'NAMEM' IS CALLED TO SAVE THE NAME OF
; THE CURRENT FILE, 'NAME' IS CALLED TO
; PRINT OUT THIS NAME ON THE CONSOLE SO
; THE USER WILL KNOW WHICH FILE IS BEING
; PROCESSED,
; THE CURRENT DIRECTORY DISK BLOCK IS
; SAVED, 'FIXIT' IS CALLED TO PROCESS
; THE FILE, AND THE DIRECTORY BLOCK IS
; MOVED BACK.
00B3'                SET:
00B3'  CD D50F        CALL DIROPN
00B6'                ..L1:
00B6'  CD D5EF        CALL DIRBLK
00B9'  C8             RZ
00BA'  FEFF           CPI 255
00BC'  28F8           JRZ ..L1
00BE'  D5             PUSH D
00BF'  CD 019E'       CALL NAMEM
00C2'  CD 01AE'       CALL NAME
00C5'  21 00F3'       LXI H,..R1
00C8'  CD D073        CALL TXTYP
00CB'  21 DA92        LXI H,RDFLNM
00CE'  11 01C1'       LXI D,BUFFER
00D1'  01 0117        LXI B,LN2SNC
00D4'  EDB0           LDIR
00D6'  2A D964        LHLD TRKWNT
00D9'  22 01BF'       SHLD TRACK
00DC'  D1             POP D
00DD'  CD 00F4'       CALL FIXIT
00E0'  2A 01BF'       LHLD TRACK
00E3'  22 D964        SHLD TRKWNT
00E6'  21 01C1'       LXI H,BUFFER
00E9'  11 DA92        LXI D,RDFLNM
00EC'  01 0117        LXI B,LN2SNC
00EF'  EDB0           LDIR
00F1'  18C3           JMPR ..L1
00F3'  8D            ..R1: .BYTE 13+128
;
; THIS ROUTINE DOES ALL OF THE WORK FOR
; ANALIZING A SINGLE FILE ON THE DISK.
; (ACTUALLY, SINCE (I MIGHT MODESTLY
; SAY) THIS IS ONE OF THE BEST EXAMPLES
; OF A WELL STRUCTURED PROGRAM I HAVE
; EVER SEEN, 'FIXIT' JUST PROVIDES
; ANOTHER LEVEL OF CONTROL FOR THE
; 'FIXIT' FIRST CALLS 'HEAD' TO SET UP
; THE CONTROL REGISTERS TO READ THE
; FIRST BLOCK OF THE FILE.  THE LOOP
; '..L1' THEN PROCESSES ALL BLOCKS IN
; THE FILE.  THIS LOOP CALLS 'NEXT' TO
; GET THE NEXT DATA BLOCK IN THE FILE,
; IT THEN CALLS 'TEST' TO TEST ITS
; DISK POINTERS.  IF THERE IS A PROBLEM,
; 'TEST' RETURNS A NONZERO FLAG.  IN THIS
; SITUATION 'FIXIT' TERMINATES.  IT DOES
; NOT CONTINUE PROCESSING A FILE WITH A
; BAD CHAIN.  IF THE BLOCK IS OK IT CALLS
; 'SETMAP' TO TURN ON THE BIT IN THE
; BITMAP FOR THIS BLOCK.  IT THEN CALLS
; 'LINK' TO SET UP THE CONTROL TO READ
; IN THE NEXT BLOCK OF THE FILE.  IF
; THERE ARE NO MORE, 'LINK' RETURNS
; WITH A ZERO FLAG AND 'FIXIT' EXITS.
00F4'                FIXIT:
00F4'  CD 0107'       CALL HEAD
00F7'                ..L1:
00F7'  CD 0116'       CALL NEXT
00FA'  CD 0121'       CALL TEST
00FD'  C0             RNZ
00FE'  CD 0129'       CALL SETMAP
0101'  CD 0133'       CALL LINK
0104'  20F1           JRNZ ..L1
0106'  C9             RET
;
; THIS ROUTINE SETS UP THE CONTROL
; REGISTERS, 'DE' AND 'HL' TO PROCESS
; THE FIRST BLOCK IN THE FILE.  SINCE A
; BACKCHAIN TEST IS GOING TO BE MADE
; BY SOMEBODY, 'DE' WILL BE USED TO KEEP
; THE PREVIOUS BLOCKS ADDRESS WHILE 'HL'
; WILL OF COURSE BE USED TO KEEP THE
; CURRENT BLOCKS ADDRESS.  FOR THE FIRST
; BLOCK IN A FILE, THE BACK POINTER IS
; DEFINED AS ZERO AND SO THIS IS THE
; VALUE PLACED IN 'DE'.  THE ADDRESS OF
; THE FIRST BLOCK IN A FILE IS CONTAINED
; IN THE 10TH AND 11TH BYTES OF THE
; DIRECTORY ENTRY FOR THIS FILE.  THIS
; IS A DISPLACEMENT OF +9.  SINCE WE
; HAVEN'T REUSED THE FDOS BUFFER, I GET
; THIS ADDRESS FROM WHERE 'DIRBLK' TOLD
; ME THE DIRECTORY ENTRY IS.  'DIRBLK'
; HAS POINTED 'DE' TO THE CURRENT
; DIRECTORY BLOCK.  THEREFORE I GET THE
; LOCATION OF THE FIRST BLOCK'S DISK
; ADDRESS BY ADDING 9 TO THIS LOCATION.
0107'                HEAD:
0107'  CD 019E'       CALL NAMEM
010A'  21 0009        LXI H,9
010D'  19             DAD D
010E'  5E             MOV E,M
010F'  23             INX H
0110'  56             MOV D,M
0111'  21 0000        LXI H,0
0114'  EB             XCHG
0115'  C9             RET
;
; THIS ROUTINE LOADS IN THE NEXT DISK
; BLOCK FOR THIS FILE.  THE FDOS ROUTINE
; 'RED256' PRESUMES THAT THE DISK
; ADDRESS OF THE BLOCK TO BE READ IN IS
; IN THE FIELD 'TRKWNT'.  THEREFORE,
; THIS IS WHERE 'NEXT' PLACES IT.
0116'                NEXT:
0116'  E5             PUSH H
0117'  D5             PUSH D
0118'  22 D964        SHLD TRKWNT
011B'  CD D75E        CALL RED256
011E'  D1             POP D
011F'  E1             POP H
0120'  C9             RET
;
; THIS ROUTINE TESTS THE CHAINS FOR THE
; CURRENT FILE BLOCK.  IF THERE ARE ANY
; PROBLEMS, IT RETURNS A NONZERO RETURN
; CODE.  ACTUALLY, YOU WILL NOTICE THAT
; 'TEST' CALLS TWO OTHER ROUTINES WHICH
; DO ALL THE WORK.  'TESTBK' TESTS THIS
; BLOCKS BACKCHAIN AND 'TESTNM' TESTS
; THE SELF CONTAINED ADDRESS OF WHERE
; IT THINKS IT IS: ITS OWN ADDRESS.
0121'                TEST:
0121'  CD 013A'       CALL TESTBK
0124'  C0             RNZ
0125'  CD 0168'       CALL TESTNW
0128'  C9             RET
;
; THIS ROUTINE TURNS ON THE BIT IN THE
; BIT MAP CORRESPONDING TO THIS DISK
; BLOCK.  THE FDOS ROUTINE 'TS2BT'
; ASSUMES THAT 'HL' CONTAINS A DISK
; BLOCK ADDRESS.  IT RETURNS THE ADDRESS
; OF THE BYTE IN THE BITMAP WHICH
; CONTAINS THE BIT REPRESENTING THIS
; BLOCK.  IT ZEROS REG. 'A' AND THEN
; TURNS ON THE BIT IN REG 'A' WHICH
; CORRESPONDS TO THE CORRECT BIT FOR
; THIS BLOCK IN REG. 'M' (THE BYTE
; POINTED AT BY 'HL').  ORING 'A' INTO
; 'M' TELLS FDOS THAT THE BLOCK IS IN
; USE.  XORING 'A' INTO 'M' (TURNING OFF
; THE BIT) TELLS FDOS THAT THE BLOCK
; IS UNUSED.  'SETMAP' TURNS ON THE BIT
; TO SIGNAL THAT THE BLOCK IS IN USE.
0129'                SETMAP:
0129'  E5             PUSH H
012A'  D5             PUSH D
012B'  CD D065        CALL TS2BT
012E'  B6             ORA M
012F'  77             MOV M,A
0130'  D1             POP D
0131'  E1             POP H
0132'  C9             RET
;
; THIS ROUTINE SETS UP THE POINTERS FOR
; PICKING UP THE NEXT FILE BLOCK.  IT
; TAKES THE CURRENT POINTER AND PUTS IT
; IN 'DE' AND PLACES THE ADDRESS OF THE
; NEXT BLOCK IN 'HL'.  IT RETURNS A ZERO
; FLAG IF THERE ARE NO MORE BLOCKS IN
; THIS FILE.
0133'                LINK:
0133'  EB             XCHG
0134'  2A DAA0        LHLD RFWLNK
0137'  7D             MOV A,L
0138'  B4             ORA H
0139'  C9             RET
;
; THIS ROUTINE TESTS THE BACK CHAIN
; POINTER.  IT TAKES THE BACK CHAIN
; POINTER FROM THE REVERSE LINK 'RRVLNK'
; AND COMPARES IT TO 'DE' USING THE
; 'DSBC' INSTRUCTION.  IF EVERYTHING IS
; OK, IT RETURNS A ZERO FLAG.  OTHERWISE,
; IT CALLS NAME TO PRINT THE NAME OF
; THIS FILE AND THEN PRINTS AN ERROR
; MESSAGE.
013A'                TESTBK:
013A'  E5             PUSH H
013B'  D5             PUSH D
013C'  2A DA9E        LHLD RRVLNK
013F'  97             SUB A
0140'  ED52           DSBC D
0142'  D1             POP D
0143'  E1             POP H
0144'  C8             RZ
0145'  F5             PUSH PSW
0146'  CD 01AE'       CALL NAME
0149'  21 0151'       LXI H,..M1
014C'  CD D073        CALL TXTYP
014F'  F1             POP PSW
0150'  C9             RET
0151'                ..M1:
0151'  2048415320     .ASCII ' HAS A BAD BAC
K CHAIN.'
0167'  8D             .BYTE 13+128
;
; THIS ROUTINE TESTS THE ADDRESS THAT
; THIS FILE BLOCK THINKS THAT IT IS
; LOCATED AT.  THIS VALUE, AT 'TRKRED',
; SHOULD MATCH THE CONTENTS OF 'HL'.
; THIS IS TESTED USING THE 'DSBC'
; INSTRUCTION.  IF EQUAL, A ZERO FLAG IS
; RETURNED.  OTHERWISE, THE NAME OF THE
; CURRENT FILE IS PRINTED OUT USING THE
; ROUTINE 'NAME' AND AN ERROR MESSAGE
; IS TYPED OUT.
0168'                TESTNW:
0168'  E5             PUSH H
0169'  D5             PUSH D
016A'  ED5B DA9C      LDED TRKRED
016E'  97             SUB A
016F'  ED52           DSBC D
0171'  D1             POP D
0172'  E1             POP H
0173'  C8             RZ
0174'  F5             PUSH PSW
```

Listing 1 continued on page 86

Listing 1 continued:

```
0175' CD 01AE'      CALL NAME
0178' 21 0180'      LXI H,..M1
017B' CD D073       CALL TXTYP
017E' F1            POP PSW
017F' C9            RET
0180'             ..M1:
0180' 2048415320    .ASCII ' HAS AN INVALI
D DISK ADDRESS.'
0190' 8D            .BYTE 13+128
;
; THIS ROUTINE COPIES THE CURRENT FILE
; NAME OUT OF THE DIRECTORY ENTRY WHICH
; IS POINTED TO BY 'DE' INTO THE HOLDING
; AREA 'NAMEH'.
019E'              NAMEM:
019E' E5            PUSH H
019F' D5            PUSH D
01A0' C5            PUSH B
01A1' EB            XCHG
01A2' 11 01B5'      LXI D,NAMEH
01A5' 01 0009       LXI B,9
01A8' EDB0          LDIR
01AA' C1            POP B
01AB' D1            POP D
01AC' E1            POP H
01AD' C9            RET
;
; THIS ROUTINE PRINTS THE NAME OF THE
; CURRENT FILE, WHICH IS IN 'NAMEH',
; USING THE FDOS MESSAGE PRINT ROUTINE
; 'TXTYP'.
01AE'              NAME:
01AE' 21 01B5'      LXI H,NAMEH
01B1' CD D073       CALL TXTYP
01B4' C9            RET
01B5'              NAMEH: .BLKB 10
01BF'              TRACK: .BLKW 1
01C1'              BUFFER: .BLKB 300H
;
; THESE ARE THE GENERAL ROUTINES DEFINED
; FOR THE USER TO USE WITHIN FDOS.
%FDGSYSMCX
D055               BYTIN = 0D055H
; C INPUT A CHARACTER FROM THE DISK
; I HL->DISK BUFFER
; O CY=EOF,A=BYTE
; K INPUT DISK BYTE IO
;
D058               BYTOT = 0D058H
; C OUTPUT A CHARACTER TO THE DISK
; I HL->DISK BUFFER,C=BYTE
; O
; M FLAGS
; K OUTPUT DISK BYTE IO
;
D05B               BLKIN = 0D05BH
; C READ A BLOCK FROM DISK.
; I HL->DISK BUFFER,BUFFER+14 CONTAINS
; I TRACK AND SECTOR TO BE READ IN.
; O CY=FAIL,BUFFER+14=NEXT BLOCK IN
; O CHAIN.
; K INPUT DISK BLOCK IO
;
D05E               BLKOT = 0D05EH
; C WRITE A BLOCK TO DISK.
; I HL->BLOCK IN BUFFER,BUFFER+10
; I CONTAINS ITS DESTINATION DISK ADDR.
; O CY=FAIL,BUFFER+10 IS DESTINATION OF
; O NEXT BLOCK
; K OUTPUT DISK BLOCK IO
;
D064               OPNIN = 0D064H
; C OPEN INPUT DISK FILE
; I HL-> BUFFER CONTAINING NAME
; O CY=FAIL
; K INPUT OPEN DISK
;
D067               OPNOT = 0D067H
; C OPEN OUTPUT DISK FILE
; I HL-> BUFFER CONTAINING NAME
; O CY=FAIL
; K OUTPUT OPEN DISK
;
D06A               CLSOT = 0D06AH
; C CLOSE AN OUTPUT DISK FILE
; I HL-> BUFFER
; O
; K CLOSE OUTPUT DISK
;
D06D               FILNAM = 0D06DH
; C INPUT, CHECK, AND PLACE A DISK
; C FILE NAME.
; I HL->DISK BUFFER
; O CY=INVALID FILENAME
; K INPUT CONSOLE DISK IO
;
D073               TXTYP = 0D073H
; C OUTPUT A MESSAGE TO THE CONSOLE
; I HL-> MESSAGE ENDING IN '80' BIT ON
;        OR '00' BYTE
; O HL-> STOP CHAR
; C C
; K OUTPUT CONSOLE ASCII BLOCK
;
D076               TI = 0D076H
; C INPUT FROM CONSOLE AND SET FLAGS
; I
; O A=BYTE CY=X'13' Z=' '
; K INPUT CONSOLE BYTE
;
D079               TXTIN = 0D079H
; C NO-OP
; I
; O
; K
;

; THESE ARE IMPORTANT ROUTINES DEFINED
; WITHIN FDOS. THEY ARE NOT DEFINED FOR
; THE USER TO USE. HOWEVER, I AM USING
; THEM ANYWAY.
%FDSSYSMCX
D686               MAPIN = 0D686H
; C READ IN ALLOCATION BITMAP OFF DISK
; I
; O
; K INPUT DISK LOOKUP BITMAP
;
D6AA               MAPOT = 0D6AAH
; C PUT BITMAP BACK ON DISK
; I
; O
; K OUTPUT DISK LOOKUP BITMAP
;
D75E               RED256 = 0D75EH
; C READ IN RECORD TO SYTEM INPUT BUFFER
; I
; O
; C EVERYTHING
; K INPUT DISK
;
D665               TS2BT = 0D665H
; C CONVERTS A DISK ADDRESS TO A BITMAP
;    ADDRESS AND BIT
; I HL=TRACK AND SECTOR
; O HL->BYTE IN BIT MAP,A=BIT IN BIT MAP
; K CONVERSION DISK LOOKUP BITMAP
;

;
; THESE ROUTINES CONTROL I/O TO THE
; DISK DIRECTORY.
%FDRSYSMCX
D5EF               DIRBLK = 0D5EFH
; C GET THE NEXT DIRECTORY ENTRY
; I
; O DE-> BLOCK
;    A=FIRST CHAR IN NAME
;    CY=END OF DIR,Z=FIRST NEVER USED
;    M=DELETED AND AVAILABLE
; K INPUT DISK DIRECTORY
;
D5DF               DIROPN = 0D5DFH
; C OPEN DISK DIRECTORY FILE
; I
; O
; K INPUT OPEN DIRECTORY DISK
;

;
; THESE ARE THE IMPORTANT FIELDS WITHIN
; THE TWO FDOS SYSTEM BUFFERS.
%FDBSYSMCX
DBAC               BITMAP = 0DBACH
; C ADDRESS OF BITMAP WHEN IN MEMORY
; I
; O
; K DISK DATA BLOCK CONTROL LOOKUP MEMORY
  BITMAP
;
0117               LN2SNC = 117H
; C SIZE OF DISK BUFFER
; I
; O
; K IO DISK DATA CONTROL
;
DA92               RDFLNM = 0DA92H
; C BUFFER FOR SYSTEM INPUT
; I
; O
; K INPUT DISK DATA BLOCK
;
DAA0               RFWLNK = 0DAA0H
; C FORWARD LINK OF SECTOR IN MEMORY
; I
; O
; K DISK DATA BYTE
;
DA9E               RRVLNK = 0DA9EH
; C BACKWARD LINK OF SECTOR IN MEMORY
; I
; O
; K DISK DATA BYTE
;
DA9C               TRKRED = 0DA9CH
; C DISK LOCAION OF SECTOR IN MEMORY
; I
; O
; K DISK DATA BYTE
;
D964               TRKWNT = 0D964H
; C NEXT SECTOR READ FOR RED256
; I
; O
; K DISK DATA BYTE
;

0000'              .END ANALIZ
ANALIZ 0000'        BITMAP DBAC       BL
KIN   D05B       BLKOT  D05E
BUFFER 01C1'        BYTIN  D055       BY
TOT   D058       CLSOT  D06A
DIRBLK D5EF         DIROPN D5DF       EN
D     0052'      FILNAM D06D
FIXIT  00F4'        HEAD   0107'      IN
IT     000A'     LINK   0133'
LN2SNC 0117         MAPIN  D686       MA
POT   D6AA       NAME   01AE'
NAMEH  01B5'        NAMEM  019E'      NE
XT     0116'     OPNIN  D064
OPNOT  D067         RDFLNM DA92       RE
D256 D75E        RFWLNK DAA0
RRVLNK DA9E         SET    00B3'      SE
TMAP 0129'       TEST   0121'
TESTBK 013A'        TESTNW 0168'      TI
       D076      TRACK  01BF'
TRKRED DA9C         TRKWNT D964       TS
2BT   D665       TXTIN  D079
TXTYP  D073  ■
```

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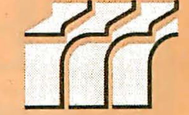
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Variables Whose Values Are Strings

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Almost every programmer has wanted to write a program in which there were one or more variables with strings as their values. Many programmers, however, are discouraged by the programming difficulties that arise in this connection, in all but the simplest cases. This is particularly true when space is at a premium and assembly language is used as it is in many microcomputer applications. We would like to describe here two alternative ways of solving these problems. These are quite different from each other stylistically; each is fascinating in its own way, and each has certain difficulties which have to be surmounted, but either one of them will solve the basic problem with which we are concerned.

Many versions of FORTRAN allow variables to have strings as their values, but these strings cannot have lengths which are greater than some maximum, and this maximum is usually much too small for practical purposes. The maximum is, in fact, the number of characters in a word, which is usually two, four or six; sometimes it is five (as on the PDP-10) and sometimes eight (as on the IBM 370, using double words), but in practice the strings we are concerned with are often 20, 40 or even 60 characters long. In many COBOL programs, this problem is taken care of by assigning some large number of characters to every such variable. This is particularly common when the value of the variable is somebody's name and address, to be printed on an envelope by the computer. Often 25 characters are reserved for the name, 25 for the address, and 25 for the city, state and zip code. This gives rise to two kinds of problems. In the first place, 25 characters is not enough for an address like 1527 San Jose-Los Gatos Rd., even if we leave the period off the end. More important, however, is the fact that, if we reserve that many characters for *every* name and every address, there are going to be quite a lot of wasted characters. That doesn't matter too much in a COBOL program, where space, particularly on a disk, is usually quite abundant; but on a microcomputer we would like to make optimum use of all the space we have.

The first solution to this problem that we will consider involves the use of a large array, called SPACE, for the storage of strings. Let us consider each element of this array to be one character long. Then the first string (whose length is L1, say) is stored in the characters SPACE (1), SPACE(2) and so on up through SPACE(L1). The next character, SPACE(L1+1), contains an illegal character code (zero, for example) to denote the fact that this is the end of the first string. The second string starts at SPACE(L1+2) and continues from there. Every string ends with a zero character code, and all the strings are stored in the array called SPACE, in sequential order.

Suppose now that these strings are supposed to be the values of variables K1, K2 and so on in the program. The actual value of each of these variables will be an integer that indicates where the corresponding string starts. Thus, for example, if 17 is the value of K2, then SPACE(17) is the first character of the given string; SPACE(18) is the next character, and so on. This is the basic concept of a *pointer:* a quantity which indicates where another quantity is in memory. The pointers we have set up have been *index pointers,* but it would have been just as easy to set up *address pointers.* That is, instead of the integer 17, we could have used the address, in memory, of the character SPACE(17).

The basic problem that arises when this method is used can be seen if we consider the process of setting a variable to a new value. Suppose that the value of K1 is 'SMITH' and we want to change it to 'JOHNSON'. Unfortunately, 'JOHNSON' has more letters in it than 'SMITH', so we cannot simply store the new characters in the same places as we stored the old ones. We can, however, take advantage of the fact that not all of our array SPACE has been used. Suppose that we have used the characters from SPACE(1) up through SPACE(LSPACE); then 'JOHNSON' can start at SPACE(LSPACE+1), and we can set the pointer in K1 to be LSPACE+1. Of course, we also have to update LSPACE at this point, by adding to it the length

of JOHNSON, or 7 (plus 1, for the zero character).

The trouble with this method is that now SMITH is still in memory, together with its zero character. We are not really using *all* the space from SPACE(1) up through SPACE(LSPACE); there are five characters, plus a zero character, that we are not using. By itself this causes no problems; but now consider what happens as our program continues to run. Every time we have a variable with a string as its value, and this variable gets a new string as its value, we are going to "abandon" some of our string storage area, just as we did with SMITH in this case. Eventually, we are going to run out of space; the whole SPACE array will be used up, except for "abandoned" areas as above. What do we do next?

Let us agree that, whenever we abandon a string, we write a zero character over the first character of that string. This character will immediately follow the zero character at the end of the preceding string, so that two zero characters in a row will denote the start of an abandoned area. We can now consider the possibility of moving all the strings backwards by just enough so that the abandoned areas disappear, as shown in figure 1. This is known as *collapsing* (or sometimes *compactifying*). If we think of the left side of figure 1 as a row of bricks, with spaces between them to represent the abandoned areas, then putting our hands on the two ends of the row and collapsing it would produce the situation shown in the right side of the figure.

An algorithm to do this involves two pointers, I and J. As we move each character in SPACE, we set SPACE(J) = SPACE(I), and then add 1 to both I and J. When we have to skip over an abandoned area, we increase I, but not J. Thus I always indicates the current character we are moving, and J always indicates the place we are moving it. At the start of the algorithm, both I and J are initialized to 1.

There is still one difficulty. All our variables with string values involve pointers, and after the collapsing process has taken place, the pointers will be wrong. We have to have some way of adjusting these pointer values. There are at least two reasonable ways of doing this. One of these involves what may be called *back pointers*. The first character (or possibly the first two characters) of each string, as given in the array SPACE, is now some indication of which variable has this particular string as its value (such as, for example, the address of that variable). Whenever a back pointer is moved, by the operation SPACE(J) = SPACE(I), we look in that position (which should contain I) and change it to J.

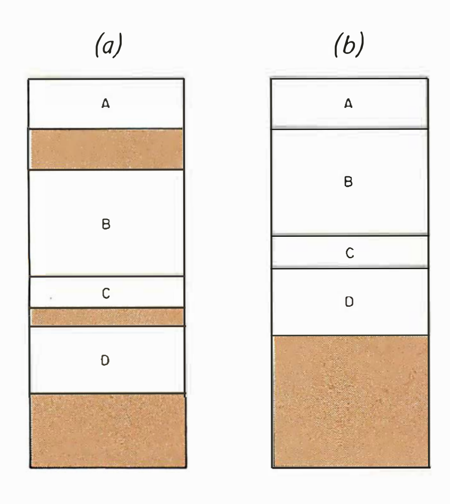


Figure 1: Collapsing or "compactifying" an array. In figure 1a A, B, C and D are separated by empty space (shaded area). In figure 1b this empty, available space is consolidated by moving B, C and D up so that they are contiguous with A.

The other method involves a sorting operation. All the pointers that are contained in all the variables with string values are placed in an array and sorted in ascending order, together with back pointers to the given variables. As we are going through the SPACE array and setting SPACE(J) = SPACE(I), we are also going through this new array, from the beginning to the end. At each stage, the pointer in this array that we are currently considering points to the place in the SPACE array that we will have to treat next, as the start of a string to be moved. When we get to this point in SPACE, we reference the associated back pointer and proceed as before; then we continue through the SPACE array, but also move forward by one position in the new array, so that we will be ready to treat that pointer when we come to it.

Whenever we abandon a string, we write a zero character over the first character of that string so we can go back later and identify the string as abandoned.

Let us now pass to the second method of handling string values of variables. Again we use a large array, which we will call FREE this time, rather than SPACE. FREE is organized into groups of characters; to make our example concrete, we will assume that each group is eight characters long. The first six of these characters are actually characters of the given string; the remaining two character positions, taken together, contain a pointer to another group of eight characters.

Any string which is less than six characters long is stored in a single group. If a string is four characters long, for example, the last two characters are zero characters; this tells us that these are not actually to be counted as part of the string. A string which is more than six characters long is stored as a chain. Thus, for example, if a string is 15 characters long, the first six of these characters appear in one group, which contains a pointer to another group. The next six characters appear in this second group,

which contains a pointer to a third group. The last three characters appear in the third group, followed by three zero characters.

If a string is exactly six characters long, it appears in a single group, but the pointer itself contains zero. If a string is 12, 18, 24, etc, characters long, it appears in more than one group, but the pointer in the last group will contain zero. In general, the pointer in the last group always contains zero, and it is this, rather than the presence of zero characters, that determines the fact that it is the last group.

We thus have one or more *chains* (sometimes called *simple lists*) which involve various 8 character groups in FREE. We are now in a position to make use of a basic idea in advanced programming techniques: the *list of available space.* In this case, the list of available space is a chain which contains all those 8 character groups, and only those groups, which are *not* on any other chain. That is, we think of all these groups as being in some order (it does not matter what the order is). Then the first group, in this order, contains a pointer to the second group; the second group contains a pointer to the third, and so on, up to the last group, which contains a zero pointer.

The point of using a list of available space is that it is now no longer necessary to use a collapsing process, as described in connection with the previous string storage method. In particular, we are no longer "abandoning" anything, as we were before. All we have to do is to make sure that, at all times, *every* group into which FREE is divided is on some chain, either the list of available space, or a chain which represents the string value of some variable. (There are also programs which use a list of available space, but in which some groups are abandoned, and a process somewhat like collapsing, known as *garbage collection,* is used to collect all these abandoned groups into a new list of available space. This, however, is necessary only when the various chains contain pointers to each other, which is not the case in the present application.)

By a pointer to a group, we mean a pointer to the first character in the group. Thus if K is such a pointer, then the group consists of FREE(K), FREE(K+1) and so on up through FREE(K+7). We will assume that FREE(K) through FREE(K+5) are the six characters in the group, and that FREE(K+6) and FREE(K+7), taken together, are the pointer to the next group. A variable called LAVS (for "list of available space") contains, at all times, a pointer to the *first group* in the list of available space. The basic operations on the list of available space are taking one group off

the front of it and adding a new group to it. The first of these operations, removing a group from the list of available space, is performed as follows:

1. Set K = LAVS; the new group will consist of FREE(K) through FREE(K+7).
2. Since this group is no longer to be on the list of available space, the first group in this list is now what used to be the *second* group. But a pointer to this second group is currently in FREE(K+6) and FREE(K+7). This pointer now has to be taken and put into LAVS, because LAVS must contain, at all times, a pointer to the first group in the list of available space.

The second of our two operations, adding a group to the list of available space, is performed as follows:

1. Suppose that FREE(K) through FREE(K+7) is the new group. This will become the first group in the list of available space, and it must contain a pointer to the second group. But the second group is the old first group, and a pointer to that group was contained in LAVS. This means that LAVS must be moved into the pointer position FREE(K+6) and FREE(K+7).
2. Since LAVS must contain, at all times, a pointer to the first group in the list of available space, we must now set LAVS equal to K.

The first operation above can be modified to check for overflow. If it is performed when the list of available space contains exactly one group, it is not hard to see that LAVS will be set equal to zero. This is not in itself an error; it merely means that all available space is being used. The next time we do this, though, there will be an error unless we check for it. Therefore, when we set K = LAVS, we should check to see if K is now zero; if so, there is an overflow condition. (We are, of course, using the word "overflow" in a generalized sense, to denote the fact that there is too much space being used for the available memory in the FREE array.)

Using these two basic operations, we can now make sure that our available space list is always kept up to date. Suppose that we have a variable J with a string value, and suppose that this string value is kept in *m* 8 bit groups. A pointer to the first of these groups will be kept in J itself. Suppose that we are now going to set J to a new string

Text continued on page 97

HOW STANLEY BEEMER AND MICROSOFT'S COBOL-80 TURNED THE OFFICE ON ITS EAR.

Stanley's office staff says Stanley always stays one step ahead. So no one was surprised when he showed up with Microsoft's COBOL-80 for the office computer. That's when things started happening.

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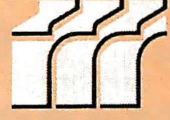
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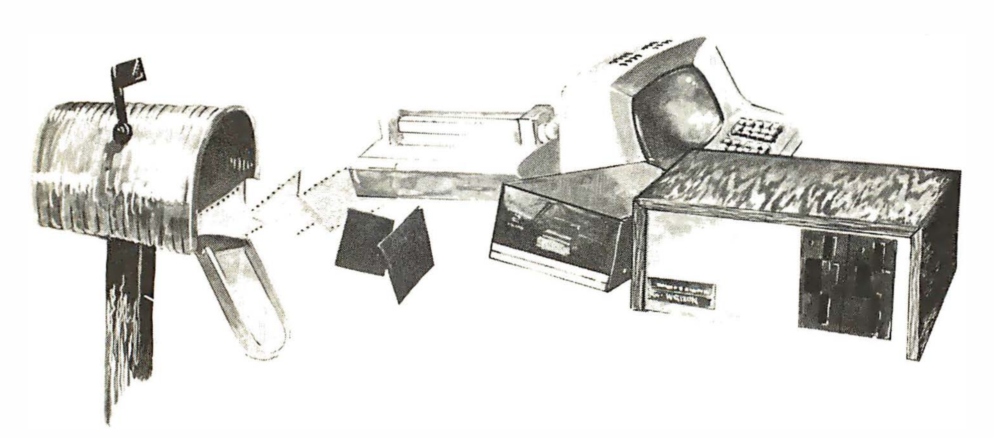
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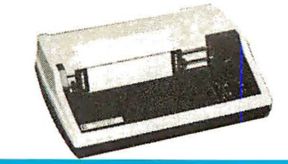
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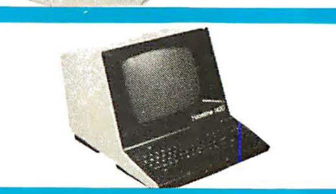
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Text continued from page 94:
value, which is kept in *n* 8 bit groups. First we apply the second algorithm above to the first group in the chain that represents the old value of J. This process puts this group on the list of available space. If $m \neq 1$, that is, if the pointer in this first group was not originally zero, we apply the same process to the second group in the chain representing the old value of J, and so on through the rest of these groups. (It is not necessary to know *m*, of course; we merely test for the pointer being zero, which indicates the last group.) Now we take *n* groups, or, in general, as many groups as we need, off the front of the list of available space by using the first algorithm above, and use these groups to store the new string value of J.

This system is quite workable as it stands; the only real problems with it come when we try to extend it. Suppose, for example, that we want to set the string value of J equal to the current string value of I. In that case we might want to save quite a bit of time by setting the pointer in J to be the same as the pointer in I. Thus we would have two pointers to the same group, or to the first group of the same chain, in the FREE area. This scheme, however, will not work unless we change our setup a bit. The problem comes when the value of I is later changed to something else. In this case the old value of I is put back on the list of available space, and this is improper because it is still the current value of J.

Let us look at this case in more detail. Suppose that the value of I is 'SMITH', and we set J equal to 'SMITH' by setting J to point to the same place that I does. Now suppose that we later set I equal to 'JOHNSON'. In this case, according to the algorithms we have discussed, the group [there is only one in this case; let us call it FREE(K) through FREE(K+7)] which contains 'SMITH' is put back on the list of available space, even though K is still the integer value of J. Now we need two groups to represent 'JOHNSON'. One of these will be this same group, that is, FREE(K) through FREE(K+7), because it was just put back on the beginning of the list of available space. This group will therefore contain JOHNSO (with the final N in the next group). This means that if at some still later time we want to print out the value of J, we will print out JOHNSON rather than SMITH.

One solution to this problem which is sometimes adopted is to reserve the first character of any string for a special integer telling us how many variables have this particular string as their value. This integer is known as a *reference count.* It is usually 1, but in the case above (where J and I point to the same string) it would be 2. Every time a variable is set to a new value, the reference count in the *old* value is decreased by 1. Only if its value is then zero do we return the space it uses back to the list of available space, because otherwise there are still variables which have that string as their value. The trouble with this scheme is that it may very easily not be worth the effort. Do we really want to add an extra character to every string, not to mention the extra testing that goes on whenever we set a string to a new value, just to be able to save a little time and space in an operation (setting one string to be the same as another) that might not be that commonly used in our program? It is certainly a debatable point.

It should also be clear that there is nothing special about the number of characters in a group (eight, in this case). The fewer characters we have in a group, the more pointers we will have, and the more space these will take up. The more characters we have in a group, the more wasted or zero characters we will have in strings, because the length of a string is not always evenly divisible by the number of characters in a group. This is a space trade-off which should be tuned by the user to fit the requirements of a particular program.■

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IBM Compatible Disk Drives

Jefferson H Harman
Director of Research and Development
PerSci Inc
12210 Nebraska Av
Los Angeles CA 90025

In today's expanding market of double-sided, multiheaded, expanded capacity, autoloading, write-protected, floppy disk drives, one requirement remains constant. Virtually all 8 inch floppy disk drives on the market are described as "IBM compatible." (Some of the smaller 5 inch drives are described as IBM compatible even though IBM doesn't manufacture equipment with the smaller drives!) Manufacturers point to it; buyers insist on it; and yet seldom does anyone define what IBM compatibility really means. That is probably because IBM compatibility is not just a single consideration. Three drives described as IBM compatible may, in fact, be compatible in 3 different ways. One drive may be IBM identical with read/write/erase head carriage and all major operating characteristics reverse engineered from an IBM 33FD drive; another drive may accept IBM type 1- or 2-sided single or double density media, but may or may not choose to employ any of the IBM data formats; and finally, a drive may be designed and manufactured with the positioning system drive motor, erase head, and other characteristics different from the IBM drives, but still be able to read and write in the IBM single or double density formats and interchange diskettes with IBM equipment.

Head

One factor does remain constant, however, among the IBM compatible drives. Virtually all of these drives, with one notable exception, bear read/write heads comparable or identical to the IBM drive (figure 1). The advantages to this design decision are clear. Whether or not the IBM design is the most efficient for the purpose does not matter. When the IBM design is employed in an independent manufacturer's drive, it assures that the drive will read back a signal comparable to that of the de facto standard (ie: IBM), thus assuring maximum interchangeability.

Because a majority of floppy disk manufacturers have chosen to remain with the standard, many systems designers must be prepared to deal with the design parameters of the IBM head, a head intended to read and write the IBM soft-sectored formats. The possibilities, limitations, and requirements imposed by this head when formatting data in floppy disk drives are the concern of this article.

Formats

The IBM 33FD head was designed to read and write the IBM soft-sectored formats. Both the drive and the concept of "soft" electronic sectoring were introduced into the marketplace by IBM in the early 1970s on the popular 3740 system. Prior to this introduction, all floppy disk drives (notably IBM's FD23) and virtually all hard disks had been hard sectored (ie: sectors were delineated by physical openings in the media or on an external sectoring device). The new electronic sectoring idea involved prewriting a certain track with track and sector identification data, then later inserting (usually on another machine) the blocks of data to be processed.

As more IBM compatible drives were offered, most users copied the IBM format. That format involves substantial *housekeeping*, and long leader and tail gap lengths; thus the available space for data on a diskette is greatly reduced. The gaps (which in fact are pulses) are used by IBM for 2 reasons: to synchronize the phase-lock loop for the data separator, and to put sufficient time between blocks of data to avoid interference of one block with another. Users were torn; on one hand they wanted more data, while on the other hand they respected the data reliability which was assured by the data bytes used to specify gaps, address marks, cyclic redundancy checks (CRCs), track and sector identification, etc, in the IBM formats. Some users struck out on their own to develop expanded formats.

The IBM formats are examples of the type which must be used with IBM heads in order to assure reliable, high-performance operation. The system engineer may choose to design his own format but, that being the case, will do well to observe the rules outlined below. At PerSci, as manufacturers of IBM compatible floppy disk equipment, we had to develop and use this set of rules. These guidelines are based upon the operating requirements and restrictions of drives with 33FD-type heads. They permit the designer to get the most available data space into the format for any given sector length or number of sectors,

About the Author

Jefferson H Harman is the director of research and development for PerSci Inc, a manufacturer of floppy disk drives.

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And because CIS COBOL conforms fully to the standard, programs written with it are portable – so if you move up to a mini or mainframe, you will be able to take your software with you.
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Environment

CIS COBOL products run on the 8080 or Z80 microprocessors under the CP/M* operating system, and on the LSI-11 or PDP-11 processors under RT-11. They are distributed in a variety of diskette formats, and have a CONFIG utility supplied as standard, enabling you to drive many different types of CRT. All are themselves written in CIS COBOL, and are therefore self-compiling and readily transferable to different operating environments – including new operating systems and new microprocessors. All of which makes CIS COBOL a very attractive proposition for OEMs as well as end-users.



CIS COBOL

OEMs

A leading semiconductor manufacturer has adapted CIS COBOL for its development systems.
We have also supplied CIS COBOL to other OEMs both in Europe and the U.S.A.
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The Compact compiler runs on 32K byte microcomputer systems.
It offers a powerful subset of ANSI COBOL facilities, including full support for random, indexed, and sequential files.
In addition, it gives you all the CIS COBOL features for conversational working, screen control, interactive debugging, and special peripheral support.

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The Standard CIS COBOL compiler requires a minimum 48K configuration.
It is a super-set of the Compact compiler and implements ANSI 1974 COBOL to full Level 1 standard. Among its advanced features are program segmentation and interprogram communication which make it ideal for implementing or converting large systems using modular programming.
The same CIS COBOL extensions are available as in the Compact compiler and can be optionally flagged at compile-time so that the compiler then only accepts strict ANSI COBOL.

Forms

The FORMS utility lets you build a screen layout online at the CRT. Then it automatically generates complete COBOL record descriptions for inclusion in your program – saving you time and leaving you free to concentrate on processing.

Forms 2

The FORMS program generator — an extension of FORMS — completely eliminates the need to write simple data entry and enquiry programs. Using it, an entire CIS COBOL source program can be generated automatically from screen definitions — and it works, first time.

Enquiries for CIS COBOL object packs and application vendor terms either to MICRO FOCUS or its licensed distributors.
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while at the same time permitting sufficient gap length to maintain data integrity.

Model Format

Table 1 is a model format for data blocks. The maximum number of sectors for any block length, N, can be easily determined by dividing the unformatted data by the total number of bytes per sector.

Using housekeeping techniques different from those shown in the model format, slight variations in the length of a sector can be achieved. For example, the user may choose not to write the cyclic redundancy check on the address field, or may increase or reduce the address marks. The minimum length of leader and tail (trailer), however, are critical, as they are determined from mechanical drive requirements.

The drive characteristics which determine the required leader and tail lengths are:

- Distance from the active part of the read/write head (read/write gap) to the active part of the tunnel erase head (erase gap).
- Variation in linear speed with track locations.
- Timing of erase turn on and off delays.
- Tolerances on these parameters.

As an example, the PerSci drives, which use a head with similar electrical and mechanical characteristics to those used in IBM 33FD disk drives (figure 1), have a distance of 0.036 inch ±0.003 inch (0.0914 cm, ±0.007 cm) from read/write gap to erase gap. The radius of track 76 is 2.029 inches (5.1536 cm), and the radius of track 00 is 3.612 inches (9.1745 cm). The drive speed is 6 revolutions per second (± 2%), and the instantaneous speed variation is ± 1.5%. PerSci requires a write clock stability of ± 0.3%.

Unformatted Data Capacity

Unformatted data capacity is determined by dividing the shortest time for a revolution by the longest time for a byte. Average speed is used for this calculation since, by definition, average speed is speed averaged over 1 revolution:

$$T = \frac{1}{6 \times 1.02} = 163.399 \text{ ms}$$

$$C = \frac{T}{16\ \mu s/\text{byte} \times 1.003} = 10{,}208 \text{ bytes}$$

C = 10,208 bytes (modified frequency modulation)
C = 5104 bytes (frequency modulation)

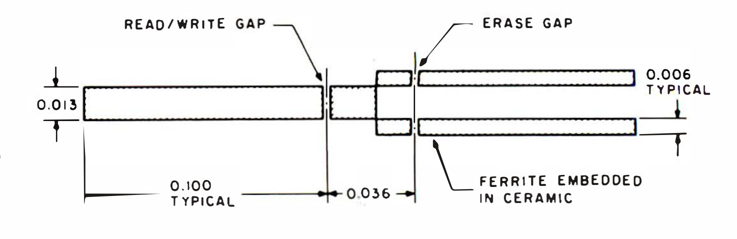


Figure 1: A view of the geometry of the contact surface of a floppy disk read/write head with tunnel erase.

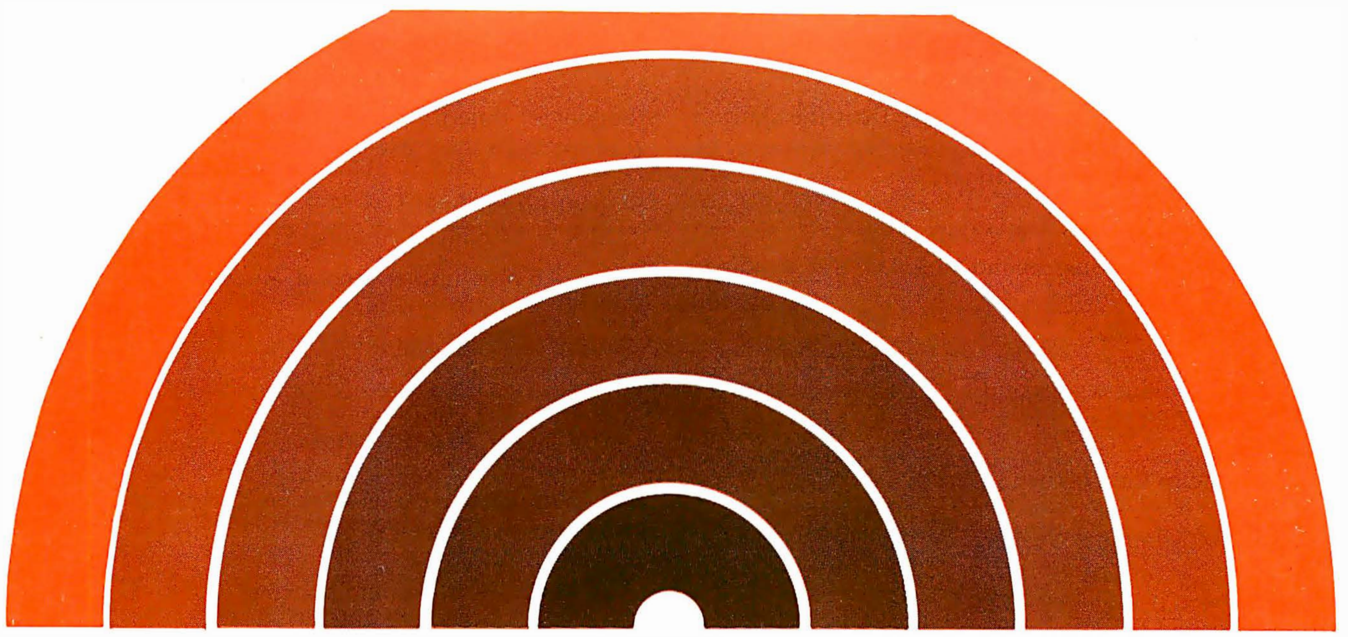
Erase Delays

The read/write head has a gap that is 0.014 inches (0.036 cm) long and thus writes a track greater than 0.014 inches (0.036 cm). After passing under the read/write gap the media next passes under the tunnel erase gaps which clean the area between tracks of any transitions. The tunnel erase also trims 0.001 inches (0.003 cm) from each side of the just written data, reducing the track width to 0.012 inches (0.030 cm). Since a 0.012 inch (0.030 cm) track is read with a 0.014 inch (0.036 cm) head, a misalignment of ±0.001 inches (0.003 cm) will cause no degradation of the data. In fact, experimentally, frequency modulated data has been recovered free of errors with deliberate 0.005 inch (0.013 cm) displacement between track center and read head.

The turn-on of the tunnel erase current is delayed from the turn-on of write current to give the disk time to travel from the read/write to the erase gap before tunnel erase begins. To insure that the data is tunnel erased, the

Purpose	Bytes Modified Frequency Modulation (MFM)	Bytes Frequency Modulation (FM)
Address leader (gap)	0.07 (N + 16) + 27	0.07 (N + 10) + 13
Address address mark	1	1
Track identification	1	1
Sector identification	1	1
Address CRC (cyclic redundancy check)	2	2
Address tail (gap)	21	11
Data leader (gap)	12	6
Data address mark	1	1
User data	N	N
Data cyclic redundancy check	2	2
Data tail (gap)	1	1
Unformatted data	10,208	5,104

Table 1: Model format for data block N bytes long. Two columns are shown giving requirements for the 2 different physical modulation formats used. The frequency modulation (FM) format is commonly referred to as "single density." The modified frequency modulation (MFM) format is commonly referred to as "double density."



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AP68-12	**6800 Extended BASIC**	**$100**
SP09-6	**6809 Extended BASIC**	**$100**

BASIC Precompiler

This program allows the creation of BASIC programs without the use of line numbers or restrictive two-character variable names. Alphanumeric line and subroutine labels may be used, as well as variable names of any length. Comment lines are marked with non-alphanumerics for easy readability. The output of the precompiler is in the standard BASIC compiled form. This allows applications programs to be written, precompiled, and then distributed in a non-source form. The precompiler can only be used with one of Technical Systems Consultants' BASICs. Specify 8″ or 5″ (5″ 6800 is FLEX™ 2.0) when ordering.

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longest turn-on delay must be shorter than the shortest time to travel from read/write to erase gap. This may be calculated in the following manner:

Maximum Linear Speed = MLS

$$MLS = 6 \text{ revolutions/second} \times 1.035 \times \frac{2\pi \text{ radians}}{\text{revolution}} \times \frac{3.612 \text{ inches}}{\text{radian}}$$

$$MLS = 140.9 \text{ inches/second}$$
$$MLS = 357.9 \text{ cm/second}$$

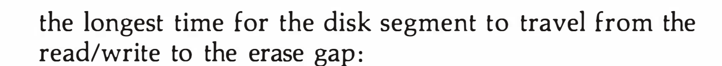
The minimum time is then given by:

$$\text{Te Min} = \frac{\text{Minimum Spacing}}{MLS}$$
$$\text{Te Min} = \frac{0.036 \text{ inches} - 0.003 \text{ inches}}{140.9 \text{ inches / second}}$$
$$\text{Te Min} = 234.1\ \mu s$$

$$\text{Erase Delay Short} = 234.1\ \mu s$$

$$\text{Nominal} = \frac{234.1\ \mu s}{1.1}$$
$$ED = 213\ \mu s$$
$$\text{ED Min} = 213 \times .9$$
$$\text{ED Min} = 191.6\ \mu s$$

Similarly, the erase turn-off delay must be longer than



the longest time for the disk segment to travel from the read/write to the erase gap:

Slowest Linear Speed = SLS

$$SLS = \text{Minimum Angular Speed} \times \text{Minimum Radius}$$
$$- 6 \text{ revolutions/second} \times (.965)\ \frac{2\pi \text{ radians}}{\text{revolution}} \times \frac{2.029 \text{ inches}}{\text{radian}}$$

$$SLS = 73.82 \text{ inches/second}$$
$$SLS = 187.50 \text{ cm/second}$$

Maximum time to travel from read/write to erase gap is given by:

$$\text{Te Max} = \frac{\text{Maximum Spacing}}{SLS}$$
$$= \frac{0.036 \text{ inches} + 0.003 \text{ inches}}{73.82}$$
$$\text{Te Max} = 5.28\ \mu s$$
$$\text{Minimum TurnOff Delay} = 528.3\ \mu s$$
$$\text{Nominal TurnOff Delay} = 587\ \mu s$$
$$\text{Maximum TurnOff Delay} = 646\ \mu s$$

Address Block Tail

The address block is written when the disk is formatted, and is rewritten only if the disk is reformatted. The format operation generally writes an entire track at one pass, completely filling the unused areas with an arbitrary pattern. User data blocks are then inserted between address blocks. The turn-on of write current when writing a user data block is timed from the address block clock; therefore, the address block will not be overwritten by the start of a data block. However, sufficient tail must be provided to prevent the erase current from being turned on during the meaningful data in the address block. If it was turned on, each successive write (assuming track alignment between writes shifts slightly) would trim away some of the address block, thus degrading data reliability until errors occurred. The tail required to prevent this occurrence is found by subtracting the quickest erase turn-on from the maximum time to travel from the read/write to erase gap:

$$\text{Address Field Tail} = TAB$$
$$TAB = \text{Te Max} - \text{ED min}$$
$$Tab = 528.3\ \mu s - 191.6\ \mu s = 336\ \mu s$$

This 336 μs will occur at *slowest* drive speed; but the write clock could be maximum. Therefore the address tail is given by:

$$\frac{336\ \mu s}{16\ \mu s \times 0.997 \times 1.035} = 20.35 \text{ bytes}$$

Use 21 bytes, since partial bytes are not conveniently written.

Data Block Tail

An address block is never inserted after a data block. Therefore, the only requirement for a tail on the data

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block is for a bit to guard the cyclic redundancy check from being at a boundary between old and new data. Use 1 byte.

Data Block Leader

The data block is always written later than the address block. Therefore, enough leader to synchronize the data separator is all that is necessary. The PerSci data separator will lock to frequency in 100 μs on any pattern and then requires 4 successive 0s to determine that the input data is clock pulses. This would require 4 bytes in frequency modulation forms. The IBM formats require 6 bytes of 0s for frequency modulation or 12 bytes of 0s for modified frequency modulation.

Address Block Leader

The address block leader must be long enough to guard against the possibility of the inserted data block of the earlier sector overwriting meaningful data; as well as being additionally long enough to prevent the erase turn-off of that inserted data block from degrading meaningful address data. Since even degraded data should be good enough to synchronize the data separator, the sum of the bytes required for the first 2 effects is all that is required. Longest erase delay minus shortest time to travel from read/write to erase gap:

$$646\ \mu s - 234.1\ \mu s = 412\ \mu s$$

$$\frac{412\ \mu s}{16\ \mu s/\text{byte} \times 0.965 \times 0.997} = 26.8 \text{ bytes}$$

27 bytes double density
14 bytes single density

To absorb the effect of speed variation between format and writing, a gap of the maximum difference in time for a data block must be allowed. A data-block double density will consist of 12 bytes of leader, 1 byte address mark, N bytes of user data, 2 bytes of cyclic redundancy check, and 1 byte of tail. This is N + 16 bytes.

Longest block time, with ±3.5% speed variation:

$$1.035 \times (N + 16) \text{ bytes}$$

Shortest Block:

$$0.965\ (N + 16) \text{ bytes}$$

$$\text{Difference} = (1.035 - 0.965)\ (N + 16) = 0.07\ (N + 16) \text{ bytes}$$

The address field leader must then become the sum of these:

$$\text{AFL} = 27 + 0.07\ (N + 16) \text{ modified frequency modulation}$$
$$= 13 + 0.07\ (N + 10) \text{ frequency modulation}$$

This leader must be terminated with enough successive 0s to synchronize the data separator.

Conclusions

The formatting rules outlined above allow for the mechanical variations of the floppy disk drive; the user can design a format to give maximum data capacity with maximum reliability. If these rules are not followed, however, the format will cause a slow degradation of the address each time a new block of user data is inserted, until the address is not readable. It is a simple matter then (with a little planning) to maintain *compatibility* with your IBM head, thus assuring the success of your non-IBM format. ■

BYTE News . . . .

THE S-100 BUS - WHAT IS ITS FUTURE?: Some industry pundits have speculated that the S-100 bus was doomed when integrated machines like the TRS-80, PET, Apple, et al, were introduced. I do not agree with this view.

There are now an estimated 200,000 S-100 systems in operation, and S-100 system sales should continue strong for a number of reasons.

The S-100 bus is not processor dependent. In fact there are presently 8080, Z80, 8085, 6502, 6800, 6809, 9900, 8086, Z8000 and MCP1600 processor boards that plug into the S-100 bus. The 68000, when it becomes available, will surely be adapted for the S-100 bus also.

It allows for extended addressing beyond 64 K bytes of memory. In fact the 16-bit microprocessors on the S-100 bus employ up to 23-bit address words and can access directly up to 2 M bytes of memory. The 8-bit microprocessors can accomplish a similar feat by a bank-switching arrangement. The Institute of Electronic and Electrical Engineers (IEEE) is adopting an S-100 standard, which should eliminate signal and timing problems and encourage sophisticated 16-bit systems.

The S-100 bus has a lot of other goodies such as vectored interrupt, direct memory access (DMA), and master/slave capabilities, which are not possible on the limited bus structures of machines such as the TRS-80, PET, APPLE, etc.

At least 3 new S-100 mainframes have been introduced so far this year. These newer boxes are capable of operating at speeds up to 10 M Hz, have larger power supplies and other features.

Those who wish to have a machine capable of getting the maximum benefits of microprocessors must go the S-100 route. The S-100 bus will thus continue to dominate the serious personal computing area for many years to come.

NEW IMAGE SENSOR USES PHOTODIODE ARRAY: An integrated circuit consisting of a 64 by 64 array of 4096 photodiodes with associated registers and accessing circuitry has been developed for video camera use. The manufacturer, Integrated Photomatrix Inc, Mountainside NJ, claims that it can produce video-quality gray scale images with illumination as low as 60 foot candles. This is 5 to 8 times more sensitive than previous devices. However, the most important feature is that it lends itself to computer processing.

RANDOM NEWS: Atari has received FCC approval for their model 400 and 800 personal computers. This will probably make the FCC less willing to grant the Texas Instruments request for changes in the rules, as the FCC finds that other companies are able to pass current requirements . . . Radio Shack will open 100 Computer Sales Departments in 100 existing stores, in addition to the 50 Radio Shack Computer Centers already in operation . . . Two pioneer personal computer companies have shut their doors and are out of business. They are Processor Technology Company and Xitan Inc (formerly TDL). Their closings are attributed to poor business management, not lack of business.

RANDOM RUMORS: Shugart is about to announce an 8 inch Winchester disk drive for under $1000. Rumor is that it will be called the Model SA-1000 and will store 5 M bytes. In original equipment manufacturer (OEM) quantities it may sell for as little as $750 . . . 5¼ inch Winchester-type drives are being investigated by several manufacturers . . . Digital Equipment Corporation's Computer Stores are proving to be a real success. Four stores are already in operation and 6 more are planned to be opened by the year's end. The stores will sell computers in the $12,000 to $18,000 range with supplies and accessories aimed at small business users . . . A record 78,843 people attended the National Computer Conference (NCC) held in New York City this past June. This was 22,000 more than last year, which also set a record . . . Sinclair Radionics Ltd, London, England, has demonstrated a flat screen (3 inch) black and white television receiver, the size of a paperback book. They are now looking for financing for the production of the unit. This may be the forerunner of the pocket computer terminal.

PERSONAL COMPUTER TIMESHARE NETWORK INAUGURATED: Telecomputing Corporation of America, McLean Va, has started a Personal Computer Network which may be accessed by home users with terminals or personal computer systems. They have about 2000 programs and data bases on-line for immediate access. Included is the United Press International (UPI) daily news file, airline schedules and real estate listings. Called "The Source", the service will be available in 200 US cities at $2.75 per hour from 6 PM to 7 AM, weekends and holidays. The rate during normal working hours will be higher.

DYNAMIC MEMORY AND THE "SOFT ERROR": As programmable memory size increases and memory cell size decreases, users are discovering that programmable memory can have *soft errors* as well as *hard errors*. A *hard error* is when a bit or bits in a given memory location is *stuck* high or low. This kind of error is easily found with a memory test and always has the same effect on the processor.

The introduction of very large-scale integration (VLSI) dynamic-memories with very small cell size has introduced soft errors which cause varying symptoms in the running of a program. A *soft error* is defined as a random, nonrecurring, bit change. The occurrence of soft errors appears to be on the increase and standard memory tests do not appear to help in diagnosing the problem.

The integrated circuit (IC) industry is becoming very concerned with the growing problem. Several integrated circuit makers have intensive research going on to discover the sources of the problem. The chief cause appears to be alpha particle radiation produced by the radioactive trace elements in the metal lids which hermetically seal the integrated circuit cavity. Several measures are being adopted by integrated circuit makers including package redesign, processing changes, and recommending that users employ error correction schemes in their memory boards to cope with the problem.

LEAVE THE DRIVING TO THE MICROCOMPUTER: Several automobile makers have research and development programs aimed at developing computer controlled cars. An example is the LISA system now under development by Volkswagen. A small console will be located on the car's dashboard. It will have a small keyboard, graphics and alphanumeric display controlled by a microprocessor. The driver will key in the code for the town he or she wishes to go to. Then as the car passes over sensor cables imbedded in the road, LISA's microcomputer transmits the car's destination to a master computer and receives instructions on the fastest and least congested route. LISA then displays a map showing the driver where to turn. LISA can be extended to control the car's speed from the information received from the master computer and an on-board radar system. Pretty soon, you will get into your car, buckle your seat belt, turn on the ignition and "leave the driving to LISA."

16-BIT MICROPROCESSORS TO DOMINATE THE 1980s: Most industry experts feel that the dominant microprocessor in personal computing and small business applications will be the 16-bit processor. They feel that prices will drop sharply, substantially reducing the price difference between 8-bit and 16-bit microcomputer systems. 8-bit microprocessors are expected to remain strong into the early 1980s because of the strong software base and significantly lower cost. However, the situation is expected to change by the mid-1980s with the 16-bit processor becoming dominant.

1980 should see at least a dozen 8086 and Z8000 processor and memory cards for the S-100 bus. The Motorola 68000 16-bit entry should make its appearance in personal computing systems by late 1980. It is interesting to note that Motorola in designing their new microcomputer development system are introducing a new Polybus which is upgradable to 32-bit service.

NONIMPACT PRINTERS IMPROVING: Considerable research is being devoted to the improvement of nonimpact printers. These efforts should bear fruit within the next 5 years, and will probably result in higher print quality, increased printing speed and greater capabilities. It is expected that quality will improve to produce type quality equal to Selectric and Diablo type printers. Speed will increase dramatically: 12,000 lines per minute will be common. Further, the printers will have multifont and graphics capabilities. Hence, they will simultaneously print the forms and the data, and put in signatures as well. Also, they will be capable of producing half-tone graphics and some even capable of multicolor printing.

LASER DISK MEMORY SYSTEMS IN DEVELOPMENT: At least 3 companies, Sperry Univac, Nippon Electric Co Ltd and Phillips Research Laboratories, are known to be working on laser disk-type data storage systems. Referred to as optical disks, they employ diode-laser recording systems which can record alphanumeric and image data on tellurium coated disks. They will be capable of substantially greater bit density than present magnetic disks.

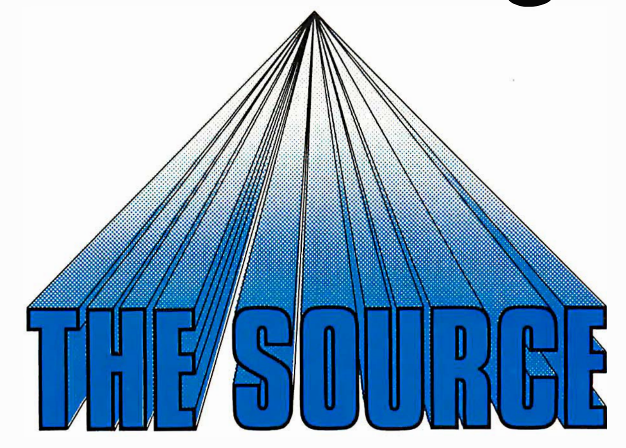
PASCAL BEING PUSHED: More and more computer manufacturers are jumping on the Pascal bandwagon. Recently, Digital Equipment Corporation, Data General and Texas Instruments introduced packages for their mini and microcomputer systems. Pascal packages have also been introduced for CPM, North Star, Radio Shack TRS-80 and Apple computers.

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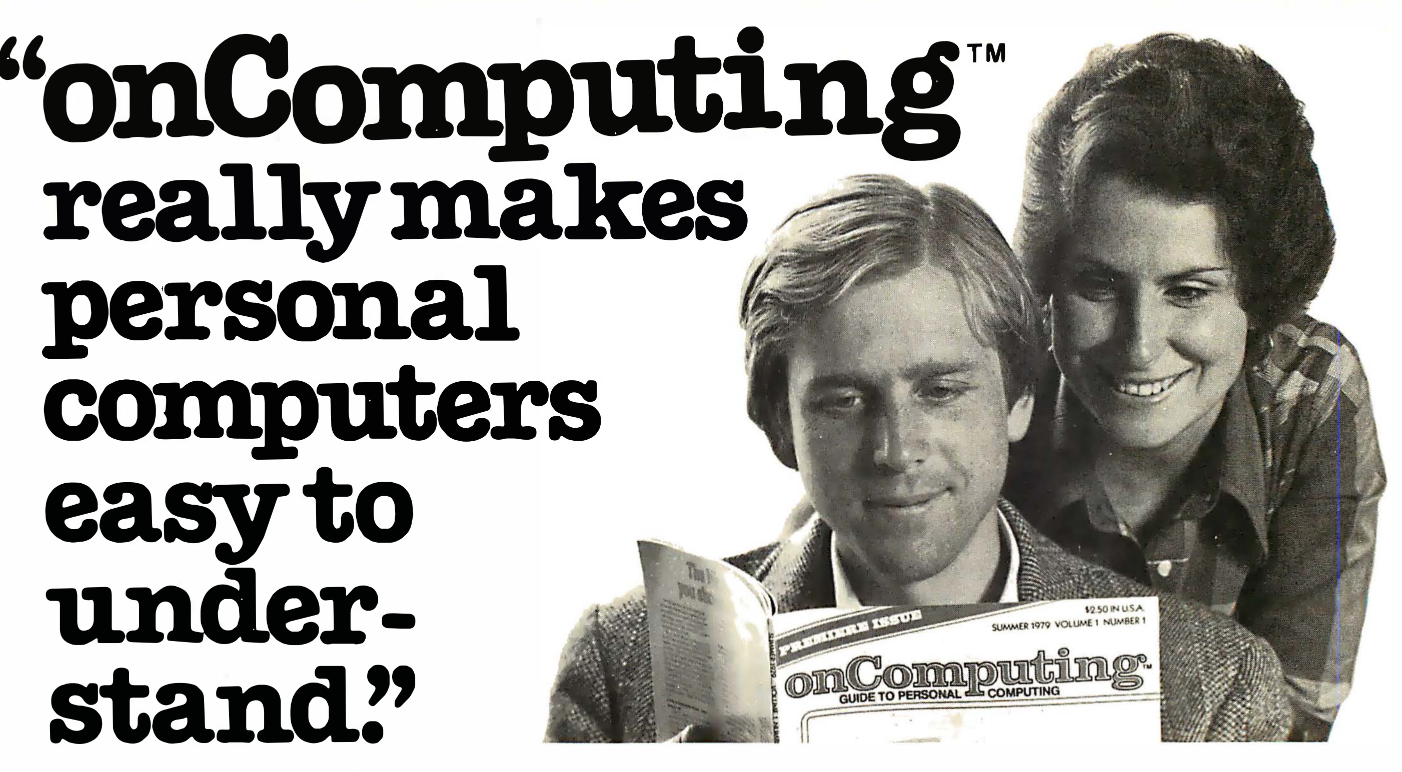
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The TRS-80 Speaks

Using BASIC to Drive a Speech Synthesizer

Tim Gargagliano
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24121 Mound Rd
Warren MI 48091

The rapidly increasing family of Radio Shack TRS-80 computer peripherals has recently acquired a voice synthesizer module. Any application of this computer system which involves human interaction can be improved with the addition of computer voice response. Voice can be used as a supplement to the video display or printer (by repeating what has been printed) or used alone when it is undesirable to print (such as for intermittent feedback while printing a long task). A few of the applications of the verbal peripheral are games, clocks, verbal prompting, alarm systems, doorbells, computer-aided instruction, and a blind user's terminal. The intent of this article is to present an overview of the voice synthesizer as a TRS-80 peripheral and to demonstrate the ease with which TRS-80 applications software can be modified to include the voice unit.

Based on electronic *phoneme synthesis*, the voice response system synthesizer is capable of producing virtually any English language word and subsets of many foreign languages. Word production is achieved by sequencing the units of sound produced by the synthesizer, referred to as phonemes. The synthesizer, developed and manufactured by the Votrax Division of Federal Screw Works, produces 62 electronic phonemes. Procedures for sequencing phonemes are discussed in the phonetic programming section.

The advantage of phoneme synthesis over other forms of speech production is its low data storage requirement. The average data transfer rate is 100 bps. Another advantage resulting from this low data rate is the negligible processor overhead associated with control of the synthesizer. This allows the computer to execute other tasks while it is generating speech. From a memory requirement standpoint, there are not any cumbersome software drivers or data tables.



Photo 1: Radio Shack TRS-80 computer system with the voice synthesizer module sitting on top of the video monitor.

Users of the TRS-80 Level I BASIC will be happy to learn that the voice synthesizer will interface with it, without any hardware modifications. This is possible by use of a special PRINT statement as an output command. (Level I BASIC does not have output commands to any device except the video display and cassette tape drive.) Level II and Disk BASIC users may also use POKE commands to drive the synthesizer.

Device Description

The TRS-80 voice synthesizer is packaged in a silver-gray cabinet with a black front grill, slightly resembling a speaker enclosure. There is a volume control and device select indicator on the front panel next to a speaker. A ribbon cable emerges from the back of the cabinet, and connects directly to the TRS-80 microcomputer keyboard module, or to the screen printer port on the expansion interface. Its length is sufficient to allow the cabinet to be placed on top of the TRS-80 video display unit.

Phonetic Programming

Phonetic programming is the operation performed to construct

About the Authors

Tim Gargagliano and Kathryn Fons are employees of the Federal Screw Works, and work in the research and development laboratory.

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VOTRAX	ASCII	DECIMAL	VOTRAX	ASCII	DECIMAL
PA1 *		32	A1	@	64
I2	!	33	AH2	A	65
I	"	34	B	B	66
I3	#	35	CH	C	67
OO	$	36	D	D	68
OO1	%	37	E1	E	69
Y	&	38	F	F	70
U	'	39	G	G	71
IU	(	40	H	H	72
A2	)	41	I1	I	73
AY	*	42	J	J	74
NG	+	43	K	K	75
AW	,	44	L	L	76
0 DEC.	–	45	M	M	77
E	.	46	N	N	78
ER	/	47	O1	O	79
PA0 *	0	48	P	P	80
AW1	1	49	DT	Q	81
AW2	2	50	R	R	82
EH1	3	51	S	S	83
EH2	4	52	T	T	84
EH3	5	53	U1	U	85
UH1	6	54	V	V	86
UH2	7	55	W	W	87
UH3	8	56	ZH	X	88
AE1	9	57	Y1	Y	89
AE	:	58	Z	Z	90
AH1	;	59	O2	[	91
THV	<	60	O	\	92
TH	=	61	AH	]	93
SH	>	62	A	^	94
WINDOW	?	63	NULL	_	95

Table 1: Relationship between Votrax phoneme symbols and ASCII characters used by the TRS-80. The decimal value of the ASCII character is also shown. The ASCII character is placed in the output window, and the synthesizer produces the corresponding sound. The synthesizer must use special phoneme characters to represent its sounds because standard alphabet characters often have several different pronunciations assigned to them.

words and phrases from the constituent sounds of a particular human language. These constituent sounds are called phonemes. The machine need produce only a subset of possible human sounds to be intelligible. Comparison of the phoneme subsets of various languages shows that there is a large intersection of phonemes between them. This means that given the phoneme subset of a particular language, several other languages can be produced from the same subset with a high degree of accuracy.

The TRS-80 voice synthesizer is an English language phoneme synthesizer. Table 1 lists all of the phonemes produced by the Votrax phoneme symbols, with the associated ASCII character and decimal code. The ASCII character, hereafter referred to as the *phoneme character*, is used in BASIC statements to select phonemes. The Votrax phoneme symbol is a mnemonic descriptor, for it spells the sound associated with that phoneme.

There are 62 phonemes from which to select. Several vowel phonemes have multiple listings, such as UH1, UH2, UH3. These are different durations of the "uh" sound. The larger the digit, the shorter the duration of the sound. The range of phoneme duration is 50 to 200 ms. The long duration version of a vowel phoneme (eg: EH1) is used in a word with only 1 vowel, or in the syllable of a word that is accented or stressed (eg: yes, better). Shorter duration versions of the vowel (eg: EH2, EH3) are used in unstressed syllables (eg: seven).

The phonemes listed in table 1 have been broken down into general groupings which are shown in table 2. In a physical sense, *voiced* phonemes can be thought of as those having pitch and amplitude resulting from vocal cord vibrations (such as are produced by humming). *Unvoiced*

(or voiceless) phonemes are those without vocal cord vibrations, where pitch might not be detected. These phonemes are perceived as hissing.

All phonemes except the stop plosives produce their sound shortly after being selected. Vocal parameters at phoneme boundaries do not change abruptly, but smoothly from one set of values to the next. The exception to this is the stop plosives, which do not make any sound until the phoneme following it begins. When a stop plosive is selected, vocal parameters are adjusted for silence until the beginning of the next phoneme. At this time, the stop plosive phoneme explodes into the following phoneme. An example of this is the word *kick*. The phoneme sequence for this word is PA1, K, I2, K, PA1. The timing of these sounds is graphically depicted in figure 1.

Phoneme symbols, with typical examples of English words in which they might be used, are provided in table 3. The English letter combination that the phoneme replaces has been underlined. In addition, table 4 shows phoneme sequences to produce

	Voiced	Unvoiced	Group Name
Consonants	B, D, G	T, P, K, DT	Stop Plosives
	Z, ZH, V, THV, J*	S, SH, F, TH, H, CH*	Fricatives
	M, N, NG		Nasals
	R, L, W, Y, ER		Semivowels
Vowels	A*, E, I, O, U		
	AW, EH, UH, AH,		
	AE, OO, IU*, AY*, Y1*		

Table 2: Votrax phoneme groupings. The allophones *(phoneme variations) marked with asterisks are phoneme variations which must be combined with another phoneme to complete the production of an English sound unit.*

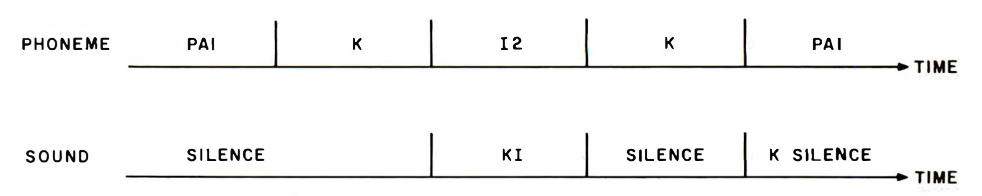
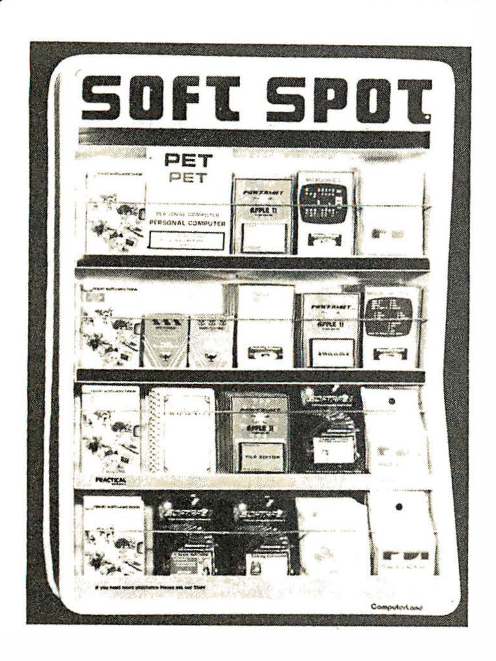


Figure 1: Progression of stop plosive sequence. The top line shows the phonemes selected during a given instant, and the bottom line shows the sound produced during that instant.

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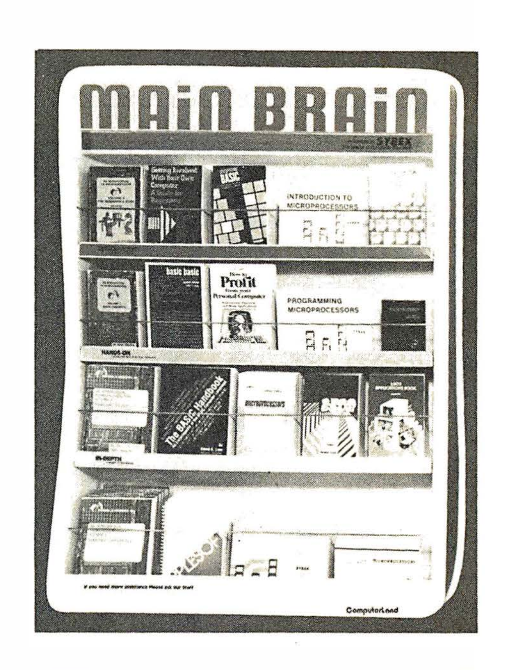
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multisound units, referred to as diphthongs. Again, the letters in the example word showing where the diphthong goes have been underlined. To give examples of phonetic programming, some commonly used computer words have been listed in table 5.

Basic Operation

Output to the voice synthesizer is accomplished by executing a PRINT AT statement (or PRINT@ for Level II), coupled with the device select/deselect character. Referring to figure 2, an imaginary box enclosing the last 32 positions of the video display is shown. This box defines a window through which printed characters are sent to the voice synthesizer. The sending of a character to the synthesizer happens when the window is open. If the window is closed, any character printed within cannot affect the synthesizer. Opening and closing the window is controlled by printing a "?" within the window. The "?" printed inside the window is considered a device select/deselect character.

As phoneme characters are printed into the open window, they are also shifted into a 32-stage first-in first-out (FIFO) buffer. This buffer is in the synthesizer interface and is address mapped into the last 32 locations of the video-display refresh memory. Phoneme characters in this buffer determine which sounds the synthesizer produces. Each phoneme duration is timed by the synthesizer. The next phoneme character is removed from the buffer at the end of each cycle. This continues until the buffer is emptied. The synthesizer will continue to process the last character entered in the buffer. This last character should be a pause (or silent) phoneme. This will prevent any sound phoneme from being produced while the synthesizer is in an unused state.

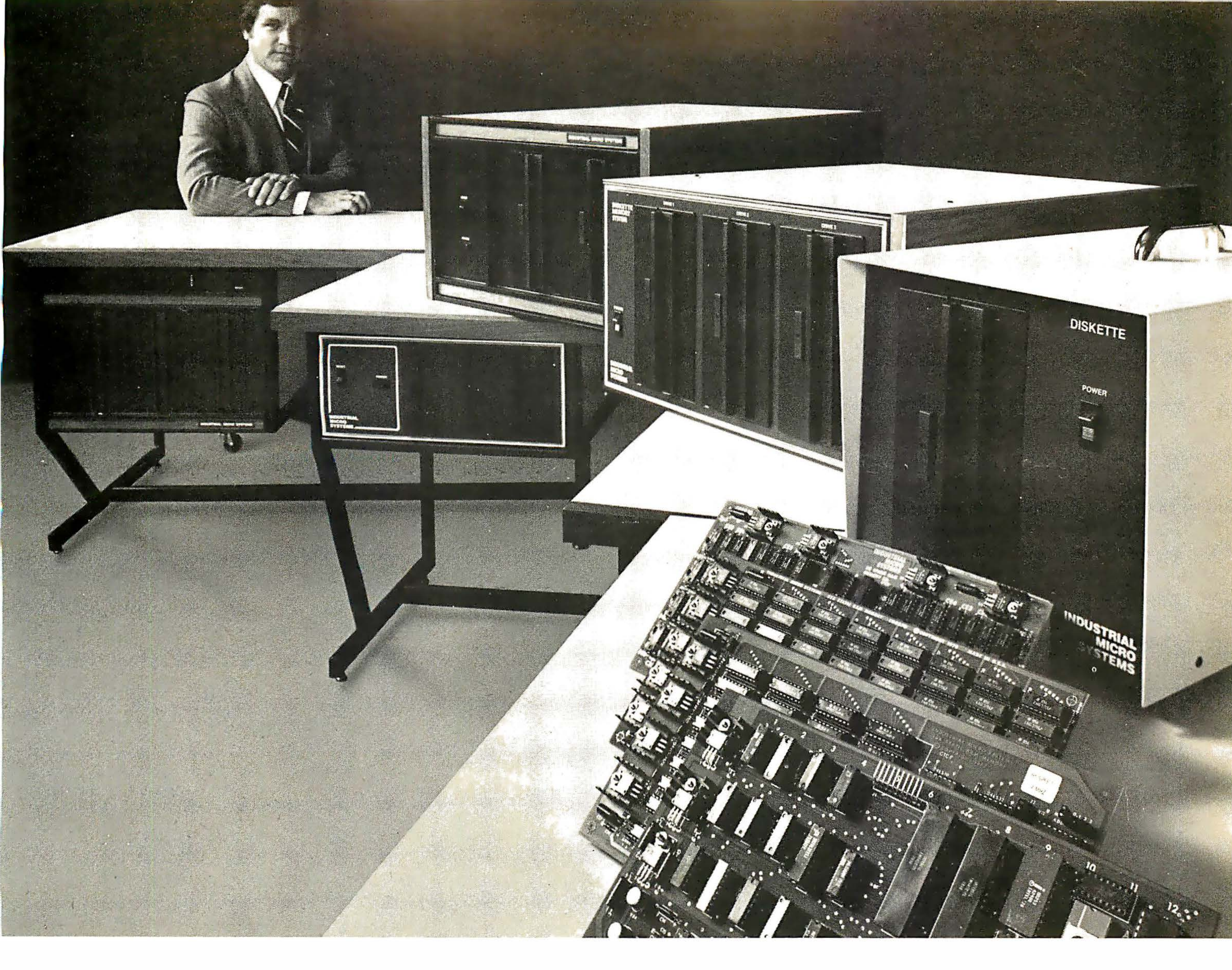
It is a good practice to set up the synthesizer output command in a subroutine. This subroutine should contain the following sequence of operations:

- Open the window (print a "?" in the window).
- Print a " " (use space bar) in the window to synchronize the synthesizer when it has been in an idle state (" " is a pause phoneme).
- Print phoneme characters in the window in the sequence they will be voiced.

Text continued on page 122

Votrax Phonetic Symbol	Key Word
B	bat - rub
D	dad - raid
G	get - log
T	tip - pat - asked
P	pack - flap - happy
K	kill - kick
DT	butter
Z	zap - haze - pans
ZH	pleasure - azure
V	van - pave
THV	the - smooth - mother
J*	job - jazz
S	soup - ask - pass - city
SH	sheep - fish - action
F	fake - cuff - phone
TH	thing - math
H	hoop - have
CH*	cheese - march - match
M	mat - dim
N	no - son
NG	ring - drink - shingle
R	race - hard - hair
L	low - late
W	wake - always - when
Y	yard - berry
A*	tame - pail - make
E	beef - be - even
I	pit - in
O	for - torn - bold
U	move - school - June
AE	dad - plaid
AW	call - paw
EH	ready - leg
ER	third - heard - churn - over
UH	around - undone - friction
OO	took - put - good
IU*	you - music
AY*	jade - made - claim
Y1*	you - music

Table 3: List of Votrax phoneme symbols with examples of the occurrence of the corresponding sound in English words. The English letter combination the phoneme replaces is indicated. The allophones (see table 2) are marked with asterisks.



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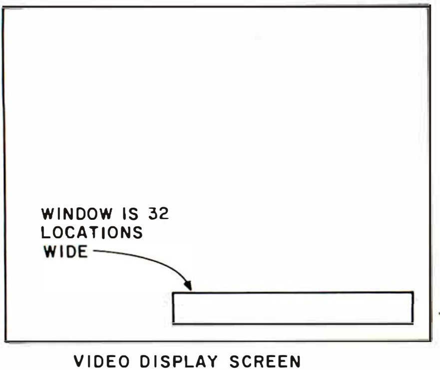


Figure 2: Location of the synthesizer output window on the video display screen. The voice synthesizer continually scans the area of memory corresponding to that region of the screen. When the vocal output is selected (by printing a question mark in the window), any character printed in the window is interpreted as a phoneme representation and is spoken.

Symbol Combination	Key Words
A1, AY	tame
Y1, IU, U1	you - unit
AH1, I2, E1	climb - crime
UH1, AH2, E1	white - night
01, U1	boat - show
AH1, U1	cow - sound
AH2, UH1, U1	mouse - about
01, UH1, E1	toy - point
A2, EH1	fare - pear
E1, I1	here - beer

Table 4: Phoneme sequences to produce diphthongs, wherein 2 vowel sounds occur adjacently, with no intervening consonant. The English letters replaced by the phoneme sequence are indicated.

Table 5: Votrax phoneme and ASCII representations of common words in computer applications. The ASCII coding may be entered directly into programs for vocal output.

BUFFER	B	UH3	UH2	F	ER	(VOTRAX)			
	B	8	7	F	{	(ASCII)			
FULL	F	OO1	OO1	L	(VOTRAX)				
	F	%	%	L	(ASCII)				
RUN	R	UH3	UH1	N	N	(VOTRAX)			
	R	8	6	N	N	(ASCII)			
STOP	S	T	AH1	UH3	P	(VOTRAX)			
	S	T	;	8	P	(ASCII)			
READY	R	EH1	EH3	D	Y	(VOTRAX)			
	R	3	5	D	&	(ASCII)			
SAVE	S	S	A1	AY	Y	V	(VOTRAX)		
	S	S	@	*	&	V	(ASCII)		
HELLO	H	EH1	UH3	L	UH3	O2	U1	(VOTRAX)	
	H	3	8	L	8	[	U	(ASCII)	
TALK	T	AW2	L	K	(VOTRAX)				
	T	2	L	K	(ASCII)				
YES	Y1	EH2	EH1	S	S	(VOTRAX)			
	Y	4	3	S	S	(ASCII)			
NO	N	UH3	O1	O1	U1	(VOTRAX)			
	N	8	O	O	U	(ASCII)			
CANCEL	K	AE1	EH3	N	S	UH3	L	(VOTRAX)	
	K	9	5	N	S	8	L	(ASCII)	
ADD	AE1	AE1	EH3	D	(VOTRAX)				
	9	9	5	D	(ASCII)				
SUBTRACT	S	UH2	B	PA0	T	R	AE1	AE1 K	PA0 T	(VOTRAX)
	S	7	B	0	T	R	9	9 K	0 T	(ASCII)
MULTIPLY	M	UH2	L	T	UH3	P	L	AH1 Y	(VOTRAX)	
	M	7	L	T	8	P	L	; &	(ASCII)	
DIVIDE	D	I2	V	AH2	AH1	EH3	I3	AY D	(VOTRAX)	
	D	!	V	A	; 5	#	* D	(ASCII)		
EQUALS	E1	AY	K	W	OO1	L	Z	(VOTRAX)		
	E	*	K	W	%	L	Z	(ASCII		
ENTER	EH1	N	T	ER	(VOTRAX)					
	3	N	T	/	(ASCII)					
ZERO	Z	AY	I3	R	UH3	O2	U1	(VOTRAX)		
	Z	*	#	R	8	|	U	(ASCII)		
ONE	W	UH3	UH2	UH2	N	N	(VOTRAX)			
	W	8	7	7	N	N	(ASCII)			
TWO	T	IU	IU	U1	U1	(VOTRAX)				
	T	(	(	U	U	(ASCII)				

Table 5 continued on page 122



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Table 5 continued from page 120:

THREE	TH	TH	R	E	Y	(VOTRAX)					
	=	=	R	•	&	(ASCII)					
FOUR	F	O1	O1	R	(VOTRAX)						
	F	O	O	R	(ASCII)						
FIVE	F	AH2	AH1	I3	Y	V	V	(VOTRAX)			
	F	A	;	#	&	V	V	(ASCII)			
SIX	S	I1	I3	K	PA0	S	(VOTRAX)				
	S	I	#	K	0	S	(ASCII)				
SEVEN	S	EH3	EH2	V	EH2	N	N	(VOTRAX)			
	S	5	4	V	4	N	N	(ASCII)			
EIGHT	A2	A2	AY	Y	T	(VOTRAX)					
	)	)	•	&	T	(ASCII)					
NINE	N	AH1	EH2	Y	N	(VOTRAX)					
	N	;	4	&	N	(ASCII)					
TRS-80	T	E1	E1	AH1	UH3	R	EH1	S	S	PA0	(VOTRAX)
	T	E	E	;	8	R	3	S	S	0	(ASCII)
	A1	AY	Y	D	Y1	(VOTRAX)					
	¼	•	&	D	Y	(ASCII)					
VOICE	V	01	UH3	EH3	Y	S	S	(VOTRAX)			
	V	0	8	5	Y	S	S	(ASCII)			
SYNTHESIZER	S	I1	N	TH	UH3	S	AH1	Y	Z	ER	(VOTRAX)
	S	I	N	=	8	S	;	&	Z	⁄	(ASCII)
COMPUTER	K	UH1	M	P	Y1	IU	U1	T	ER	(VOTRAX)	
	K	6	M	P	Y	(	U	T	⁄	(ASCII)	
SPEECH	S	P	E1	Y	T	CH	(VOTRAX)				
	S	P	E	&	T	C	(ASCII)				
PHONEMES	F	02	02	N	AY	Y	M	Z	(VOTRAX)		
	F	[	[	N	•	&	M	Z	(ASCII)		
OPERATOR	AH1	P	ER	A1	AY	T	ER	(VOTRAX)			
	;	P	⁄	¼	•	T	⁄	(ASCII)			

```
1000 PRINT AT 992,"? ";A$;" ?";
1010 PRINT AT 992,"                               ";
1020 RETURN

1000 PRINT@ 992,"? ";A$;" ?";
1010 PRINT@ 992,"                               ";
1020 RETURN
```

Listing 1: Subroutines for synthesizer output in Radio Shack Level I (listing 1) and Level II (listing 1b) BASIC. Line 1000 opens the output window in the video display, sends a pause, sends the phoneme characters stored in A$, sends another pause, and closes the window. Line 1010 fills the window with 31 spaces to blank out the display. Line 1020 returns to the calling routine.

```
1000 POKE 16383,63 : POKE 16383,32
1010 FOR Y = 1 TO LEN (A$)
1020 POKE 16383, ASC(MID$(A$,Y,1))
1030 NEXT Y
1040 POKE 16383,32 : POKE 16383,63 : POKE 16383,32
1050 RETURN
```

Listing 2: Modified subroutine for synthesizer output for Level II BASIC only. Phoneme characters are taken out of A$ one at a time, and are POKEd into decimal location 16383, the last location in the output window. This method of output does not disturb the cursor position, thereby saving overhead of restoring the cursor.

Text continued from page 118:

- Repeat last step if multiple messages are desired.
- Print a " " in the window (a pause for silence at the end of the message).
- Close the window (print a "?" in the window).
- Print spaces in the window to blank out the characters in the video display that were sent to the synthesizer.

An example of this sequence is shown in listing 1. A variation on this subroutine which Level II users might consider is shown in listing 2.

The phoneme character strings which form words when sent to the synthesizer may be stored in several ways. The simplest way is to store the phoneme strings in a BASIC string variable and then call the voice driver subroutine. An example is A$="TUD@Y": GOSUB 1000. This transmits the phoneme characters for the word "today." DATA statements may be used to create a lookup table where the English spelling of a word is stored adjacent to the phoneme character string for that word. This would be useful, for example, in creating a name storage table for a game. A user could enter his or her name from the keyboard, and the computer could search the table for a name match and the associated phoneme characters needed to pronounce the name. It is a funny sensation to be verbally addressed, by name, by a computer.

Summary

Merely reading about how to string phonemes together on a TRS-80 voice synthesizer cannot begin to convey the excitement your friends will experience when your computer talks to them. Applications of a voice response system are exciting and plentiful. Any TRS-80 computer can add this voice synthesizer unit without any hardware modification. Changing existing application software to include voice response requires inserting only a few lines of code. Applications of computers in the home will surely come to rely on voice response as one of the most important output devices. ■

Interfacing the S-100 Bus With the Intel 8255

David L Condra
161-C Springdale Rd
Carrollton GA 30117

Upon entering the world of microcomputers, technical terms such as data bus transceiver, parallel port, PDBIN, and strobe can appear to be hopelessly confusing. Consequently, many people avoid hardware and concentrate their efforts on software, feeling that it is easier to understand. However, as with software, if a hardware project is broken down into manageable modules, it can be easily designed and understood. This is particularly true with the new large-scale integration devices that are available today. Use of these parts almost forces a modular approach to a design problem.

When faced with the job of designing an interface for a Diablo printer, I began looking at the available interface parts. I was amazed at how simple these devices can make an interface design project. In this article I will discuss the Intel 8255 programmable peripheral interface, and its use for interfacing to the S-100 bus. My objective, both in designing the interface and writing this article, is to reduce the problem to its simplest and most essential elements.

I learn easily and enjoy the learning more when I am working on a specific application, rather than merely reading technical material or doing routine experiments. Therefore, this discussion is offered as a simple I/O (input/output) interface design that will allow the nonhardware-type person to build a working interface and gain some basic understanding of the functions of hardware in a microcomputer. This is not intended to be a straight hardware tutorial; additional study in some areas may be required to fully understand what is happening.

Intel 8255 Description

The 8255 is one of a later group of interface integrated circuits which Intel Corp introduced to support the 8080 and related processors. It is a general purpose program-

Use of large-scale integration parts forces a modular approach to a hardware design problem.

mable device with 24 pins that may be programmed in a variety of configurations. A programmable device can have its operating characteristics modified by a processor command. For example, in a programmable serial interface, a single output command can set data rate, number of stop bits, and parity status.

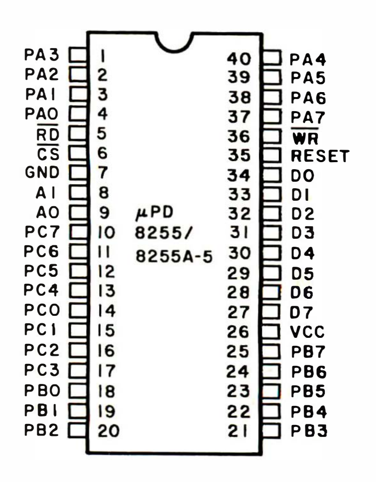
In a parallel interface part like the 8255, a single output command can define how the 24 programmable I/O pins are to be used. Such uses include input, output, handshaking, and interrupts. The 8255 is normally set up so that its control register looks like an I/O port to the processor. The processor sends a specific data byte to that port to determine the mode of operation.

The 8255 modes are as follows:

- Mode 0: (Basic I/O) Each group of 12 I/O pins may be programmed in sets of 4 and 8 to be input or output.
- Mode 1: (Strobed I/O) Each group of 12 I/O pins may be programmed to have 8 lines of input or output with the remaining 4 pins in each group being used for handshaking and interrupt control signals.
- Mode 2: (Strobed Bidirectional Bus I/O) This is a bidirectional bus mode which uses 8 lines for a bidirectional I/O bus and 5 lines for handshaking.

In addition, there is a bit set and reset feature that allows the setting and resetting of any 1 of 8 output bits

PIN CONFIGURATION



PIN NAMES

D7-D0	DATA BUS (BI-DIRECTIONAL)
RESET	RESET INPUT
CS	CHIP SELECT
RD	READ INPUT
WR	WRITE INPUT
A0-A1	PORT ADDRESS
PA7-PA0	PORT A (BIT)
PB7-PB0	PORT B (BIT)
PC7-PC0	PORT C (BIT)
VCC	+5V
GND	0V

BLOCK DIAGRAM

POWER SUPPLIES
+5V
GND
GROUP I CONTROL
GROUP I PORT A (8)
I/O PA7 THRU PA0
GROUP I PORT C UPPER (4)
I/O PC7 THRU PC4
BI-DIRECTIONAL DATA BUS
D7 THRU D0
DATA BUS BUFFER
8-BIT INTERNAL DATA BUS
GROUP II PORT C LOWER (4)
I/O PC3 THRU PC0
RO
WR
A1
A0
RESET
READ/ WRITE CONTROL LOGIC
GROUP II CONTROL
GROUP II PORT B (8)
I/O PB7 THRU PB0
CS

Figure 1: Configuration and names of pins of the Intel 8255 programmable peripheral interface and block diagram of its functional parts.

using a single output instruction. Figure 1 is a diagram showing pinouts and a block diagram of the Intel 8255. As can be seen, the 8255 combines many logic functions which would have previously required substantial design effort themselves. Since the 8255 is available in a single package form, however, it becomes essentially a 1-piece parallel interface requiring very little external logic.

S-100 Bus Description

At first glance, the S-100 bus with its 100 lines is quite overpowering. However, if one looks only at the signals needed for a specific application, it becomes much more understandable. For example, in the application of interfacing the 8255, we need only:

- Lower 8 address lines (A0 thru A7).
- 8 data-in lines (DI0 thru DI7).
- 8 data-out lines (DO0 thru DO7).
- 2 status lines:
  (1) SINP (input).
  (2) SOUT (output).
- 3 control lines:
  (1) $\overline{\text{PWR}}$ (processor write).
  (2) PDBIN (processor data bus input).
  (3) $\overline{\text{POC}}$ (power on clear).

Note: The bar above some signal names indicates that these signals are logically active when low; other signals are active high (+5 V).

The reason that you see more bus lines used on most I/O boards is that S-100 boards are usually designed to be very flexible and to serve multiple functions; therefore you find I/O boards using clocks, interrupts, and other functions. Since, however, our objective is to keep things simple, we will confine this application to the bus lines listed above.

S-100 to 8255 Interface Design

We begin our design at the 8255. After examining the various modes in which it can operate and determining that its output and input capabilities are sufficient, it becomes a straightforward matter of determining what signals the 8255 needs to function and how we can obtain them from the S-100 bus. The signals which we need to generate for the 8255 are as follows:

- A $\overline{\text{CS}}$ (chip select) signal to turn the 8255 on.
- A0 and A1 signals to select 1 of 4 ports (A,B,C, or control).
- Data control on pins D0 thru D7.
- A $\overline{\text{WR}}$ (write) signal to tell the 8255 to take the output data from the processor bus and send it out to the appropriate port(s).
- A $\overline{\text{RD}}$ (read) to take input data from the appropriate port and put it on the processor bus.
- A reset signal which clears the 8255 internal registers.

Our problem becomes how to generate these signals using the S-100 bus lines defined above.

Text continued on page 129

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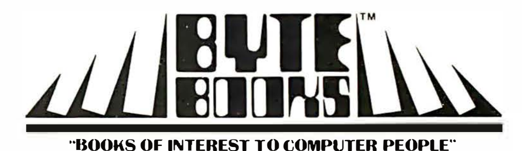
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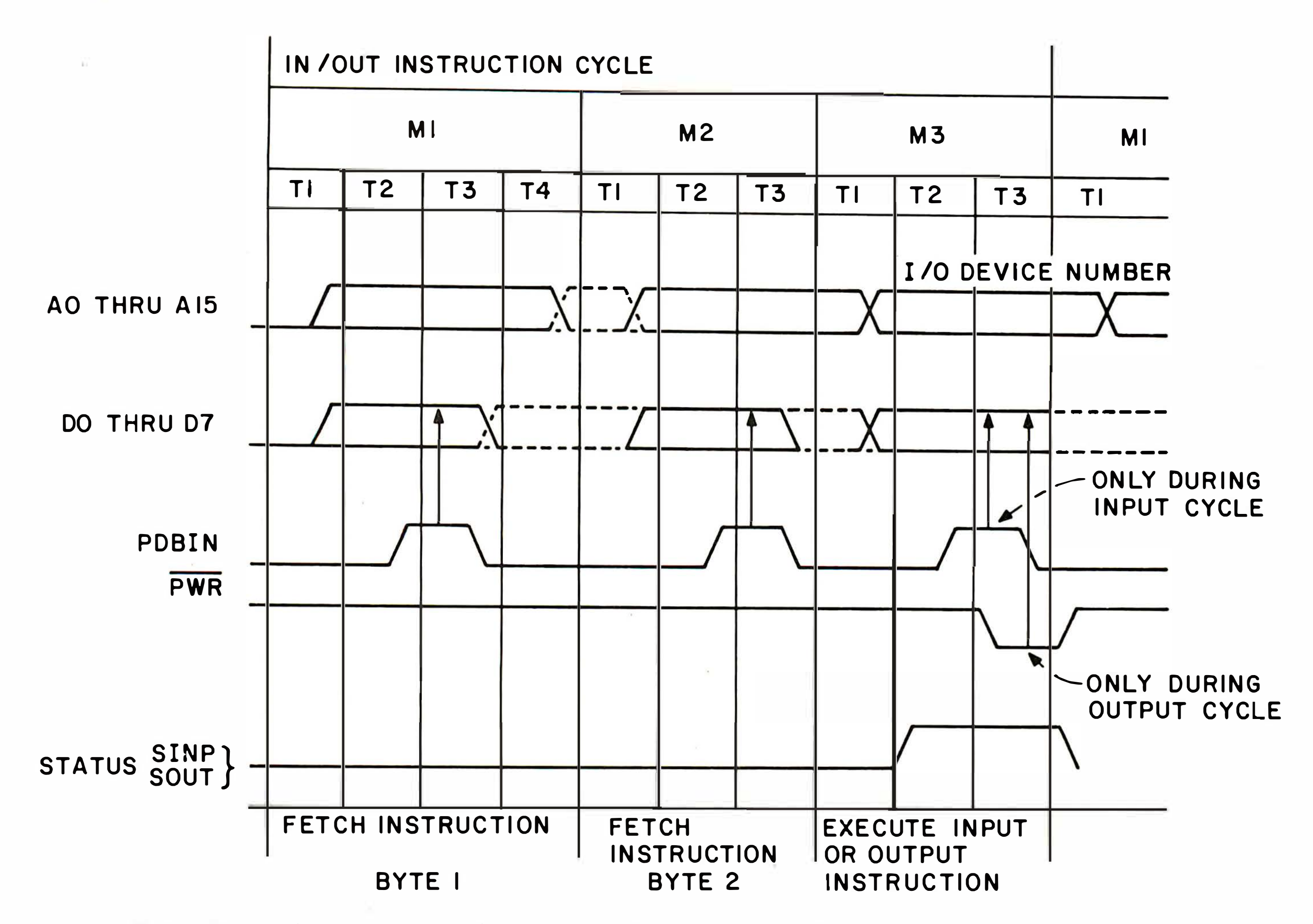


Figure 2: Timing diagram showing signals on the S-100 bus during a data transfer instruction.

An understanding of timing diagrams is essential in designing any hardware interface.

Chip Select Signal

The $\overline{CS}$ (chip select) signal is basically an on/off signal for the 8255. To avoid stray data being output or input when not desired, the 8255 device is kept disabled until the processor commands that the data be input or output through one of the 8255's ports. To do this, we must understand the definition of the S-100 bus signals which we need to use. This is best explained through the use of a timing diagram as shown in figure 2.

In most respects the S-100 bus timing is based on the 8080 processor signals. These diagrams indicate the state of the bus lines with respect to time and their interaction with each other. Most confusing, at first glance, are the data and address signals which appear to be high and low at the same time. This, of course, merely represents the idea that some of the bits may be high and some may be low when valid and active.

Starting at the bottom of the timing diagram, we see that the S-100 status signals SINP and SOUT are inactive in a low-logic state anytime except during the third machine cycle of an input or output instruction, respectively. By using a simple OR gate (such as the one shown as IC2a in the circuit diagram of figure 3), we can turn on the 8255 programmable peripheral interface whenever the SINP *or* SOUT signal is high. The inverters IC1a and IC1b are used for convenience and to minimize the number of integrated circuit packages used. They also serve as bus receivers, allowing these signals to drive other circuitry on the same board.

The SINP and SOUT signals could be used to turn on the 8255 every time the processor executes an input or output instruction; however, we want the 8255 to pass data only when it is specifically addressed. To be more exact, we want the 8255 to take action only when a specific *port* on it is addressed by the processor. Therefore, we need to know when the processor is addressing one of these ports.

The upper and lower bytes of the address bus lines will contain the address of the I/O port during the third

Table 1: Power supply connections for integrated circuits in figure 3.

Number	Type	+5 V	GND
IC1	74LS04	14	7
IC2	74LS00	14	7
IC3	DM8131	16	8
IC4	DS8833	16	8
IC5	DS8833	16	8
IC6	μPD8255	26	7

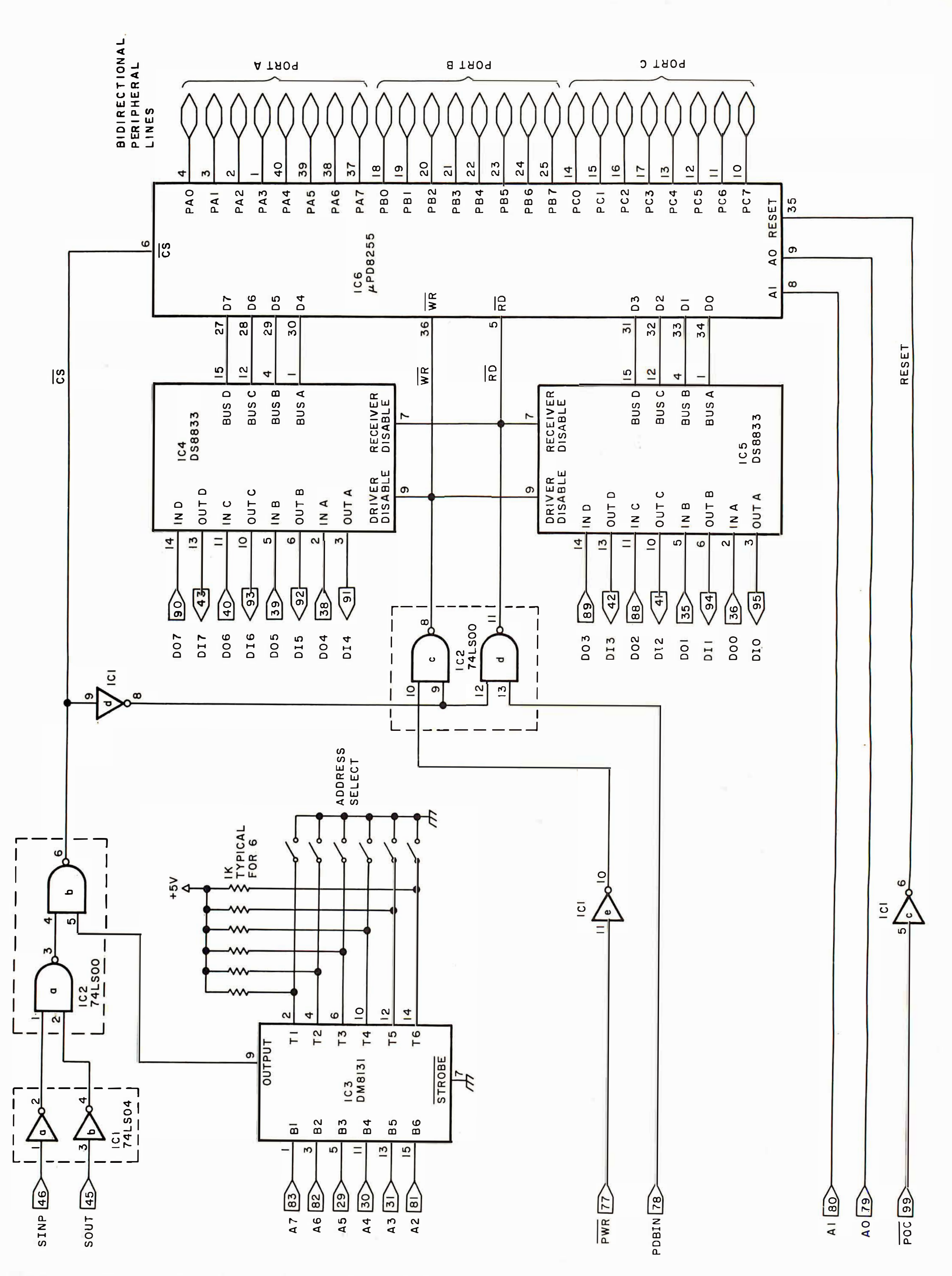


Figure 3: Schematic diagram of an interface circuit using the 8255 device. All numbered connections refer to pins on the S-100 bus. A suitable power supply is assumed, with connections for integrated circuits given in table 1.

machine cycle of an I/O instruction. Therefore, what we want to do is decode the lower 8 address lines continuously. When one of the ports on the 8255 is selected, we want an *enable* signal which we can combine, using a logical AND, with the status signal to turn on the 8255.

A simple method of decoding the address bus is to use a comparator (such as the 6-bit comparator 8131) which will take the enable pin (pin 9) low when the input signals from the bus match the pattern set as the port address. In this case, we are using only the upper (most significant) 6 bits of the port address, since the lower 2 bits will be used to select 1 of 4 ports on the 8255 itself.

We can set up the port address by tying the appropriate lines on the 8131 comparator to either high or low-logic levels as required to match the address. We now have circuitry which will provide a $\overline{CS}$ (chip select)signal whenever the processor is in an input or output instruction cycle, and whenever any of the port numbers assigned to the 8255 have been addressed by the processor.

Address Lines A1 and A0

As can be seen, pins 9 and 8, carrying low-order address signals A0 and A1, can now be tied directly to the lines A1 and A0 on the S-100 bus. This will allow the processor to select port A, B, C, or control function.

Data Transfer

We have now enabled the 8255 at the appropriate time. The remaining task is to supply the data to the data pins on the 8255 or retrieve the data from the appropriate data pins on the 8255 when the processor is doing an output or input instruction with this port.

The data pins on the 8255 are bidirectional (ie: they will take data from the bus and output it to the appropriate port when the $\overline{WR}$ signal is active, or will take data from the port and put it on the bus data lines when the $\overline{RD}$ signal is active). Since the S-100 bus is divided into 8 unidirectional lines of *data in* (DI0 thru DI7) and 8 unidirectional lines of *data out* (DO0 thru DO7), we need a means of tying both of these sets of lines to the 8 data pins on the 8255 and selectively enabling either the S-100 data input or data output bus lines.

An easy way to accomplish this is with the 8833 bus transceiver integrated circuit which can be connected as shown in the circuit diagram of figure 3. When pin 9 on the 8833 is active, the data will be passed from the data output bus to the 8255, and when pin 7 is active, the data will pass from the 8255 to the data input bus of the processor. The S-100 bus provides 2 simple signals with which to achieve this result.

The $\overline{WR}$ Signal

The $\overline{PWR}$ signal, as shown on the timing diagram (figure 2), will go low when valid data is presented on the data output lines. We can use this signal to enable the 8833 bus transceivers and to strobe (send a pulse to) the 8255 pin $\overline{WR}$ to pass the data to the appropriate output port.

The $\overline{RD}$ Signal

Conversely, we see from the timing diagram that the S-100 signal PDBIN is active in a high-logic state when valid data can be accepted on the data input line. We can use this signal to generate the $\overline{RD}$ signal for the 8255 to pass the data from the appropriate 8255 input ports to the data pins, and to enable the 8833 bus transceivers so that the data is passed directly to the data-in bus in the processor.

One other provision which we want to include in our design is that the $\overline{RD}$ and $\overline{WR}$ signals should not be allowed to go active unless the $\overline{CS}$ (chip select) signal is also active. This provision is primarily for the purpose of keeping extraneous data which might be on the 8255 data lines from being transferred to the data-in (DI) bus at any time that the PDBIN signal is active. We can achieve this by using the AND gates IC2c and IC2d to generate the $\overline{RD}$ and $\overline{WR}$ signals *only* when the 8255 has been selected *and* the appropriate $\overline{PWR}$ or PDBIN signal is simultaneously active.

Reset Signal

This leaves us with one simple signal which is needed by the 8255. Since the 8255 can start in an undefined state when power is first supplied to it, a reset signal is necessary to bring it to a known state for further use. Fortunately the S-100 bus provides us with a very convenient $\overline{POC}$ (processor on clear) signal that can be tied through an inverter to the reset pin. This arrangement will apply a reset signal to the 8255 whenever power is applied to the processor.

We have now designed a simple but powerful interface circuit. As you can see, the parts count of 6 integrated circuits is quite low. The circuit could conceivably be put on a simple piece of perforated circuit board and hung onto an existing S-100 board. The total cost should not exceed

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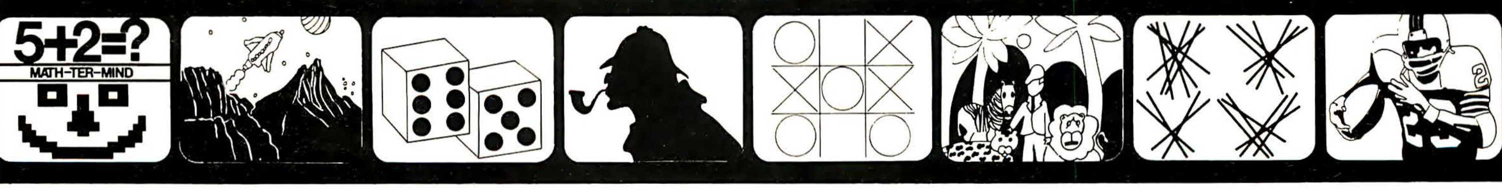
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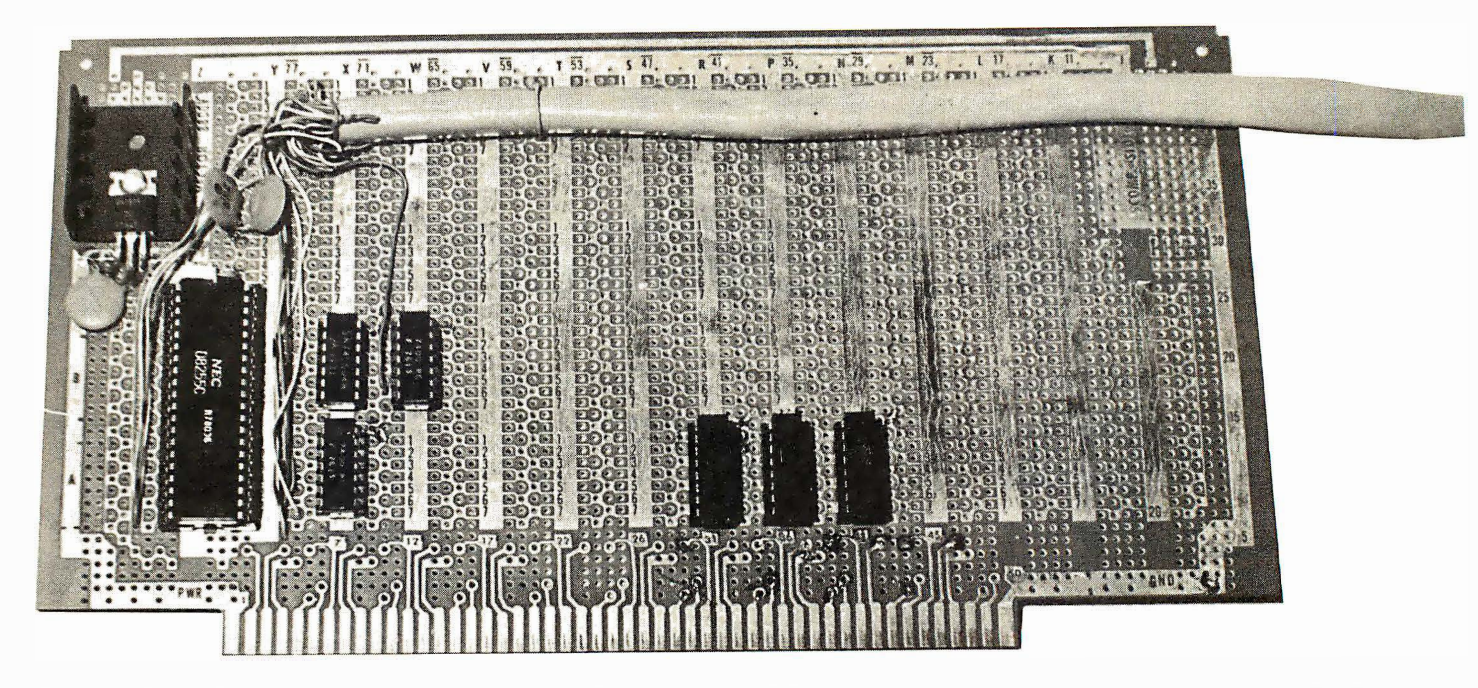


Photo 1: The author's prototype of the interface circuit, built on an S-100 prototype board. The bus transceiver and decoding integrated circuits are located on the bottom of the board. An extra 7400 NAND gate package was added for a special application.

Any 1 line on the S-100 bus must be connected to only 1 TTL integrated circuit on any 1 circuit board.

$20. This mounting would not be advisable, due to space and maintenance problems. I would recommend using an S-100 prototype board such as one provided by Vector Electronics, which has provisions for a voltage regulator plus power and ground distribution buses on board.

The wiring can then be done point-to-point with wire wrap. There will also be plenty of available room and power for additional circuitry on board. Circuits for other functions would be very easy and economical to add, since we have already provided for data bus transceiving, and we can use many of the same bus interface integrated circuits to add additional circuitry to the board.

One caution — be aware that the S-100 bus expects to see only 1 TTL (transistor-transistor logic) "fan-out" load per board, which means that any given bus line must be tied to the input of *only 1* TTL device on the board. The bus line should not be driving 2 or more TTL devices simultaneously. Therefore, if additional circuitry uses the same bus signals, a bus receiver (7404 hex inverter) or driver (8T97 3-state buffer) must be used between the bus lines and the board circuitry.

Check-Out and Troubleshooting

One problem in trying to build other people's designs is that usually you are not given any troubleshooting information. Therefore, when it is built and does not run, you have to learn it inside out to make it run. You do learn a lot in the process, but a few guidelines, such as the following, can speed up the process considerably:

- Buy a computer with front panel lights and switches. Although manufacturers seem to be drifting away from making true front-panel controls, they are invaluable if you are going to do any hardware design or debugging. A single-step capability alone can help a great deal, but for my money give me as many switches and lights as possible.

- Get an extender board so that you can place your circuit board where you can get at it. For tracing circuits, checking power supplies, and other general debugging, it is indispensable.
- Test power supply connections to the circuit board before plugging integrated circuits into their sockets. (Use sockets!) Plug in the integrated circuits and recheck power and ground on each one. Then single-step through an output instruction using one of the I/O port numbers you have assigned to the 8255.

  When the *out* status light on the front panel (or on a logic probe you are holding on pin 45 of the S-100 bus) comes on, the processor is in the output phase of its instruction cycle and you have static conditions to check out the circuitry. By looking at the circuitry you can see that $\overline{CS}$ should be low, $\overline{WR}$ should be low, and there should be some data on the data pins of the 8255 (ie: either highs or lows, but not open circuits). If these conditions do not exist, trace back through the circuit to the bus and find the problem.
- Once you are able to output data to the 8255, you can proceed to check it out according to specifications given in the application data. For a start, you can output the hexadecimal value 94 to the control register port, which will set port A for input and port B for output. Then you can try input and output commands as you would a normal port.

You will probably experience some frustrations in trying to make the interface work. However, when you finish you will probably know more about how your computer works than you ever thought possible.

Applications

Typical applications for such an interface include peripheral devices where up to 24 I/O bits are required. This might be as simple as an 8-bit parallel interface needing only a strobe and acknowledge signal (which is a clearly defined mode 1 for the 8255), or as complex as the Diablo printer interface which requires 12 data lines, 6 status lines and 6 strobes. In fact, it is difficult to conceive a parallel device which could *not* be interfaced with this circuit.

In conclusion, for any interface application you have in mind, check first to see what special large-scale integration devices are available. You might find that the entire design can be accomplished through the use of one of these special parts. For more data I recommend the 8080 series applications manuals from Intel Corp, National Semiconductor, and Texas Instruments, and also Don Lancaster's *TTL Cookbook* and manufacturers data sheets on the 8833 and 8131. Good luck! ■

REFERENCES

1. *Intel MCS-80 Users Manual*, October 1977, Intel Corp.
2. Lancaster, D, *TTL Cookbook*, Howard W Sams and Co, Indianapolis, 1974.

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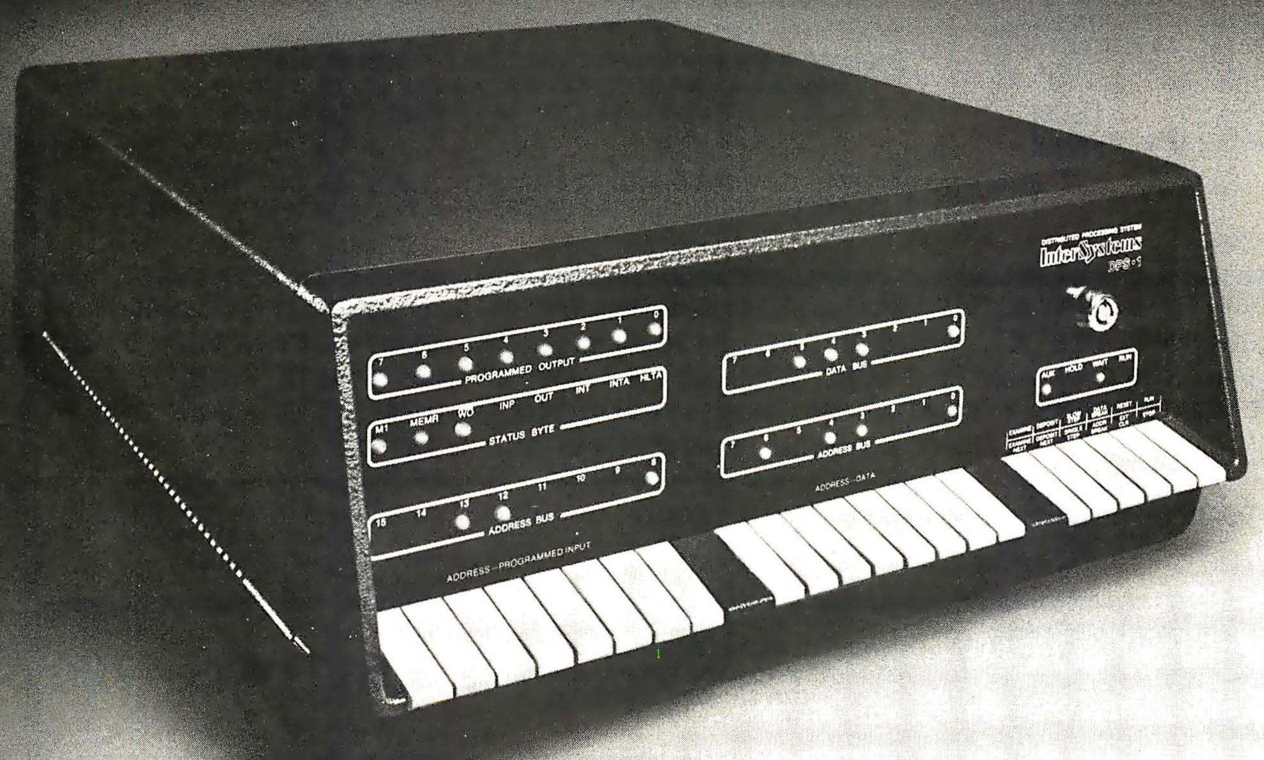
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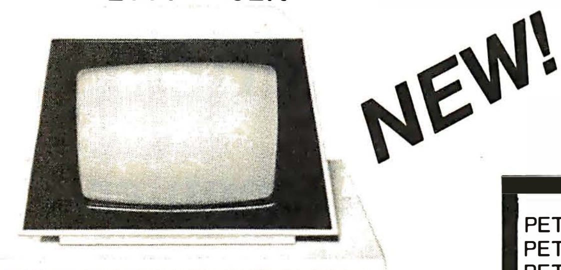
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When I was small, I visited my grandmother's house on a hill in Salem, Oregon. The house was just below a peak of the steep hill, and on the peak was a large fir tree. From high in that tree, using my uncle's binoculars (not authorized for use in trees!), I could look out over Salem on a summer day and see Mt Hood floating above the horizon. Its white cone was hazy and immense. Between me and the mountain lay 60 miles of town and country, looking like artificial scenery painted on layers of glass, one stacked close behind another. The binoculars compressed perspective, just as they magnified lateral dimensions, squeezing those 60 miles of hills, ridges, and forest into what looked like about a thousand yards.

Inside my grandmother's house was another marvel, also a binocular device: a stereopticon and a huge collection of pictures to look at. The effect was just the opposite of the scene from the tree with the binoculars. A card holding 2 flat and apparently identical pictures was slipped into the frame. Holding the device by its wooden handle and slipping the cupped eyeshield over my eyes, I saw the flat pictures turn into startling solid objects in a world that lay beyond the translucent frame of the pictures, extending from arm's reach to at least the distance of Mt Hood. Some were frightening views down cliffs in the mountains of Switzerland, where my grandmother was born.

I was about 6 or 7 when I discovered the stereopticon, and was soon told that using it so much was bad for my eyes. When that pronouncement was made, the viewer was put away. However, I knew where the pictures were, and quickly developed a skill that was probably worse for my eyes. I learned to look at them walleyed, and to fuse the pictures without the viewer. You can learn to see the stereo pairs described in this article that way if you like; you can also do it by crossing your eyes. It takes patience and practice, since you have to uncouple the focus of your eyes from their convergence (normally, when we converge our eyes to see something close, the lenses automatically focus for near distance). In a stereo pair of pictures, all the objects are at the same distance, and you have to learn to keep them in focus independently of the convergence of your eyes. I learned to do that when I was 7, so you can probably learn to do it, too. In case it is too much of a strain, we will have a look at a simple viewer that is easy to put together. I use the viewer because it gives better depth.

Illinois in the winter of 1978 was a long way from the clear, warm summer days in Oregon in the early 1930s. However, when I bent over the drawings my computer had produced (using the objective lenses from an inexpensive pair of binoculars balanced on a pair of rulers as a viewer), and saw the tangled lines sink below the paper and stand in space above it, I felt a pang of joy that connected me instantly with that small boy in Oregon long ago. We get bigger and change shape, but the important things stay the same. That is the real reason for writing this article. It is for phenomenon fans.

Calculating Stereo Plots

To make a stereo picture, construct 2 views of the same 3-dimensional object as seen from each of a viewer's eyes. Placing a picture in front of each eye, you see the 2 images fused. In order to fuse near objects, your eyes have to converge just as for the real object, since near objects are displaced more (to the side opposite the viewing eye) in the 2 pictures, than are the actual far objects. The most natural viewing requires using 2 identical lenses, one in front of each eye, and a cardboard shield to keep each eye from noticing the wrong picture.

Stereo effects arise from image displacements left and right; in the vertical dimension, stereo pictures are essentially identical. The *size* of the vertical dimension shrinks as the distance to the object increases, but by the same amount for both eyes.

Figure 1 shows the situation from the top of the viewer's head. The actual pictures will be at some fixed distance, Z0, from the person's eyes or the lenses of the viewer. Letting the horizontal direction in the plane of the person's eyes be the X axis (with the origin lined up with the nose), and the Z axis be the direction away from the nose (up, in figure 1), it can be determined where the image of any point in space will be in the picture.

The coordinates of a point (X,Z) are shown in figure 1. This point forms the farthest corner of a right triangle, the other far corner being directly ahead of the person's left eye, and a distance E left of the Z axis (for this eye, E will be a negative number, being to the left). The length of the far side of the right triangle is thus $(X-E)$.

The corresponding point on the paper is (X1, Z0). X1 is the X position

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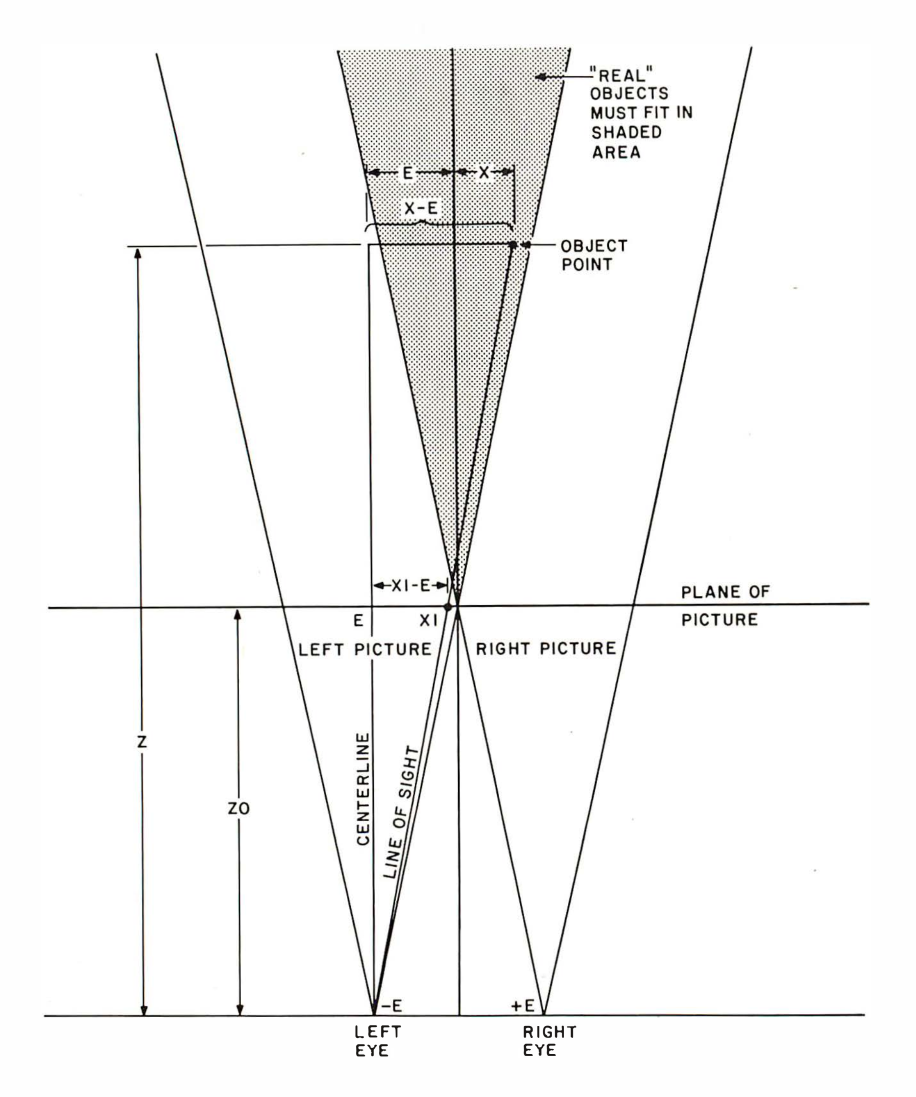


Figure 1: Geometry of generating stereo pictures. Each point of the object to be pictured is projected along the line of sight to the plane in which the picture will be drawn.

where the line of sight to (X,Z) pierces the picture. A smaller right triangle is formed, with (X1,Z0) as the farthest corner and (E,Z0) as the other far corner. The far side of this triangle has a length of (X1−E).

By similar triangles, we thus have:

$$(X1 - E)/(X - E) = Z0/Z$$

or

$$X1 = (X-E)\times Z0/Z + E$$

That transfers any point at a distance X to the right of center (or −X to the left) and any distance Z from the person's nose into the plane of the picture. For the picture seen by the left eye, E is a negative number (half the distance from eye to eye), and for the other picture E is positive.

The Y dimension (up and down from the person's point of view) is handled exactly the same way, with the exception that there is no displacement of the eyes above or below the centerline of the picture; in effect, E is 0, and Y is substituted for X in the equation above. That yields:

$$Y1 = Y\times Z0/Z$$

With these 2 elementary equations we can transform any point with coordinates X,Y,Z into a point X1,Y1 for each eye to view. Then, running X, Y, and Z through space to trace out a figure, we can generate the 2 pictures in terms of X1 and Y1, to produce a pair of stereo pictures.

Constructing Pictures

If you do not have an X,Y plotter, you can still make perfectly good stereo pictures using straight lines. For example, to make a cube, first calculate the coordinates of the 8 corners of the cube as X,Y,Z coordinates. Then apply the above equations to convert each X,Y,Z triple into an X1,Y1 pair. Do this twice, once with E set to about −1.25 inches and then with it set to +1.25 inches (a typical interocular [between the eyes] distance is about 2.5 inches, close enough). Z0 is set to the viewing distance you plan to use, or the focal length of the viewing lenses. Plot the 2 sets of points on graph paper. A simple BASIC program will make the conversions easy.

Finally, and with great care, use a felt-tipped pen or pencil and ruler to connect the points that correspond to edges of the cubes in the 2 views; straight lines are transformed into straight lines. Voilà! View the pictures stereoscopically, and you have a 3-dimensional cube. Thick lines work better than thin ones, but try to keep the width uniform.

If you have a high-resolution graphic display such as the Apple computer has (and if the display is not too nonlinear), you can make plots and view them directly on the screen. I have a 15 year old X,Y pen plotter which shakes a little, but still produces fairly accurate lines, and the program given here is for that device. I have computed a few stereo pairs for your amazement. The program I used can make 3-dimensional Lissajous figures with a few modifications you can easily enhance, if you wish. This program is shown in listing 1.

Tips on Producing Pictures

It is difficult to get a good stereo effect if there is too much distance between near and far parts of the same object. I have found that with a viewing distance of 6 inches from the generated pictures, a good object will fit into about an 8 inch cube at an average *real* distance of about 30 inches.

This size limitation is also important because the object must be small enough that both eyes can see all of it. An object that is too large will have its images displaced toward each other enough to overlap, which spoils the effect. The object in real space must fit into the shaded region of figure 1. The program will do odd things if figures get outside that limit. Human binocular vision works best for objects closer than 20 feet, so place the objects accordingly.

Listing 1: Stereo plotting program in North Star BASIC. The picture coordinates are first generated and stored, then the stored list of coordinates is scanned and plotted.

```
10 REM  PROGRAM FOR GENERATING 3D STEREO IMAGE PAIPS
20 REM       WILLIAM T. POWERS, DECEMBER 1978
30 REM
40 REM
50 REM    SET Z0 TO FOCAL LENGTH OF VIEWING LENSES OR
60 REM    VIEWING DISTANCE FROM EYES IF NO LENSES USED
70 REM
80 Z0=6
90 H=100\K=3.141592654/180\K1=100\K2=2*3.141592654\O=2.5\M1=0
100 DIM M$(3000)\!%#9F2
110 REM * * * * * * * * * * * * *
120 REM DEVICE 31= PEN LIFT
130 REM DEVICE 30= Y OUTPUT
140 REM DEVICE 29= X OUTPUT #1
150 REM DEVICE 28= X OUTPUT #2
160 REM * * * * * * * * * * * * *
170 REM
180 REM      * * * * * * * * * * * *
190 REM      SET PLOTTING PARAMETERS
200 REM      * * * * * * * * * * * *
210 REM
220 OUT 31,0\Z9=SIN(SIN(SIN(1)))
230 INPUT "X, # CYCLES: ",N1\N1=N1*K2/100
240 INPUT "   PHASE: ",B1\B1=B1*K\IF B1<0 THEN B1=B1+K2
250 INPUT "   SIZE: ",S1\ S1=S1/2
260 INPUT "   POSITION: ",D1
270 INPUT "Y, # CYCLES: ",N2\N2=N2*K2/100
280 INPUT "   PHASE: ",B2\B2=B2*K\IF B2<0 THEN B2=B2+K2
290 INPUT "   SIZE: ",S2\ S2=S2/2
300 INPUT "   POSITION: ",D2
310 INPUT "Z, # CYCLES: ",N3\N3=N3*K2/100
320 INPUT "   PHASE: ",B3\B3=B3*K\IF B3<0 THEN B3=B3+K2
330 INPUT "   SIZE: ",S3\S3=S3/2
340 INPUT "   POSITION: ",D3
350 INPUT "   LINEAR,K4*T: ",K4
360 INPUT "SIZE FUNCTION: S(1+K5T). K5= ",K5
370 Q=127\GOSUB 960\INPUT "SET PEN, HIT RETURN",A$
380 REM
390 REM        * * * * * * * * *
400 REM        FIGURE GENERATION
410 REM        * * * * * * * * *
420 REM
430 FOR E=-O/2 TO O/2+.01 STEP O
440 OUT 31,0\Z9=SIN(SIN(SIN(1)))
450 P1=B1\P2=B2\P3=B3\T=0\D=0\M1=0
460 G=1+K5*T
470 Z=S3*G*SIN(N3*T+P3)+D3+K4*T
480 X=S1*G*SIN(N1*T+P1)+D1
490 Y=S2*G*SIN(N2*T+P2)+D2
500 GOSUB 770\T=T+D\IF T>100+D THEN 510 ELSE 460
510 GOSUB 570\Q=128\NEXT\OUT 31,0\ GOTO 220
520 REM
530 REM        * * * * * * * * *
540 REM        PLOT STORED IMAGE
550 REM        * * * * * * * * *
560 REM
570 P=0\OUT 31,0\FOR J=1 TO 10\Z9=SIN(1)\NEXT
580 FOR J=1 TO M1-1 STEP 2
590 X=ASC(M$(J,J))-128\Y=ASC(M$(J+1,J+1))-128
600 REM    ADJUSTMENT FOR TWO'S COMPLEMENT OUTPUT
610 IF X<0 THEN X=256+X\ IF Y<0 THEN Y=256+Y
620 REM    ANALOG OUTPUTS
630 OUT 29,X\ OUT 30,Y\ IF P=1 THEN 690
640 REM    IF PEN IS UP, OUTPUT X AND Y SEVERAL TIMES
650 REM    TO ALLOW D/A CONVERTERS TIME TO CATCH UP.
660 REM    PAUSE BEFORE LOWERING PEN.
670 FOR L=1 TO 15\OUT 29,X\OUT 30,Y\OUT 28,Q\NEXT
680 FOR L=1 TO 5\Z9=SIN(1)\ NEXT\P=1
690 OUT 31,40\OUT 28,Q\NEXT\RETURN
700 REM
```

Listing 1 continued on page 146

The maximum horizontal dimension in inches for an object at a distance of Z inches is:

$$X_{max} = 2.5\times(Z - Z0)/Z0.$$

For Z0=6 inches, as in my system, this works out to a width of 10 inches at 30 inches distance, 20 inches at 54 inches distance, and 30 inches at 78 inches distance.

How to View Stereo Pairs

The easiest viewing method is to cross the eyes or let them diverge (either will work, although the picture turns inside out if you cross the eyes). This requires practice, and I suppose it is bad for the eyes. (I am not an ophthalmologist and neither was my grandmother.) It is less of a strain to use a pair of lenses; here is a way to do it.

To make my kludge-variety viewer, I unscrewed the objective lenses from a pair of Squire 7 by 35 binoculars. These lenses have about a 6 inch focal length. You can measure the focal length with a ruler, measuring from the lens to a sharp image of a distant scene on a sheet of paper. Support the 2 lenses above the plane where the generated stereo pair is to be placed, the distance being the focal length of the lenses. This distance becomes Z0 in the equations, in inches. Any pair of lenses about 1 to 2 inches in diameter and having about a 4 to 10 inch focal length will do. View with your eyes as close to the lenses as possible.

I supported the lenses by laying 2 rulers across 2 stacks of books, far enough apart to support the lenses without obscuring too much of the field. I taped the ends of the rulers to pieces of cardboard, so they could be moved as a unit with the lenses supported over the gap. Sliding the 2 lenses together and apart permits fairly major adjustments to be made. This will accommodate different interocular distances to get the best stereo effect with the least effort. Of course, if you have steady hands you can just hold the lenses.

It is essential to have the pictures aligned in the vertical direction, which is done by tilting your head left or right, or by moving a lens slightly up, while moving the other slightly down. Once the images are fused in your perception, you can tolerate

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Circle 6 on inquiry card.



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Listing 1 continued:

```
710 REM     * * * * * * * * * * * * * * * * * * *
720 REM     STORE IMAGE POINTS AS ASCII STRING
730 REM     * * * * * * * * * * * * * * * * * * *
740 REM
750 REM   NEXT TWO LINES PLOT STEREO POSITION
760 REM
770 U=Z0/Z
780 X=(X-E)*U*K1\ Y=Y*U*K1
790 REM
800 REM   NEXT 3 LINES ADJUST STEP SIZE
810 REM   TO MAINTAIN CONSTANT RESOLUTION
820 REM   ON PLOT
830 REM
840 D=D+(2.8-ABS(X-L1)-ABS(Y-L2))/K1
850 IF D<0 THEN D=0
860 L1=X\ L2=Y
870 REM
880 REM   BIAS X AND Y FOR CONVERSION TO ASCII
890 REM
900 X=INT(X+128)\Y=INT(Y+128)
910 M1=M1+1\M$(M1,M1)=CHR$(X)\M1=M1+1\M$(M1,M1)=CHR$(Y)
920 RETURN
930 REM
940 REM   ZERO PEN FOR POSITIONING (CENTER)
950 REM
960 FOR J=1 TO 5\OUT 29,0\OUT 30,0\OUT 28,0
970 Z9=SIN(SIN(SIN(1)))\NEXT\RETURN
```

about 5 degrees of mismatch in tilt, but that is *after* they fuse.

Do not be impatient. Simple artificial pictures, which lack richness of detail and nonbinocular distance cues, take the brain a while to figure out. Pictures will not just suddenly jump into 3 dimensions. Instead, they gradually *ooze* into shape, the impression of depth growing stronger the longer you look. It gives interesting insight into the depth perception process used by the brain. Once the depth appears, you can look away and back and not lose it, and you can move your eyes all around freely. It seems that the brain gradually constructs a model of the object. When you switch from looking at one part to looking at another part, the convergence of the eyes becomes automatic, anticipating what is required for various parts of the picture.

Program Notes

The accompanying program of listing 1 is written in North Star BASIC. In order to make the plotting pen move fast enough to make clean traces without spreading the ink, I have done the process in 2 stages: first the picture is generated and stored; then the stored list of X,Y coordinates is scanned and plotted. This is done for each picture, left and right, in turn. If you want to plot directly (as you would do on a video display screen where plotting speed is essentially instant), you can eliminate the storage phase (GOSUB 770 in line 500) and substitute a call to the plotting subroutine. You would also delete the GOSUB 570 in line 510. The plotting subroutine would consist of lines 770 and 780 followed by the commands to plot X and Y, and a RETURN statement — much simpler.

My analog output is generated with a Cromemco D+7A board, which can produce 7 independent outputs. The digital-to-analog converters (DACs) have only 8 bits of resolution, and my plotter can plot about 100 points per inch. To get the maximum possible resolution I have used 2 analog outputs for the X axis. One, device 28, simply puts out either −2.56 V or +2.56 V; the other, device 29, puts out the same range of voltages representing the variations in Y. This makes it possible to plot each picture, left and right, with the full resolution of 256 elements. The recorder has a voltage differential input, so device 28 goes to the negative input and device 29 to the positive input.

In lines 370 and 510 you will observe a variable Q that is set to 127 for the left picture and 128 for the right picture. A value of 127 output to a converter corresponds to the maximum *positive* voltage of 2.55V.

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* Retail prices may vary at individual stores and dealers.



Circle 318 on inquiry card.

Applied to the *negative* recorder input, this biases the pen to the left. A value of 128 (hexadecimal 80) corresponds to -2.56 V, and biases the pen to the right.

Lines 770 and 780 do the actual conversion from X,Y,Z coordinates to X,Y stereo coordinates. You will notice that the equation for the stereo value of X is not quite the same as the above equation; the added constant E has been left off. This results in the picture being plotted relative to the point straight ahead of the relevant eye in the X direction; this permits the highest possible resolution. The auxiliary X output from device 28 inserts the missing value of E into the plot. If you are plotting on a high-resolution video display, you can write the *first* statement in line 780 as:

X = ((X - E)×U + E)×K1

and eliminate all statements involving Q (in lines 370, 510, 670, and 690). At the same time, the scale factor K1 (line 90) should be adjusted to reflect the actual number of points per inch on the display. I ran the recorder at 2 V per inch, which works out to K1 = 100; if I had not used device 28, I would have run at 1 V per inch and used K1 = 50.

The plotting parameters are set in lines 220 to 360. For X, Y, and Z the program asks for the number of full sine wave cycles to be plotted, the phase angle at which each variable is to start (in degrees), the size of each plot in inches (from left edge to right edge, bottom to top, or near to far), and the position of the *center* of the range of variation of each plot.

For the Z axis only, there is also a linear term that is requested: the constant K4 sets it. For every plot, the parameter T runs from 0 to 100, and the Z coordinate has the amount K4×T added to it. Thus if K4 is 1, the Z coordinate will have 100 inches added to it by the time the plot finishes. If the Z size is set to 0, the Z coordinate will move linearly away from the viewer during the plot.

The last item requested is a size factor. The size of the pattern for all 3 variables is multiplied by a variable G, computed from G = 1+K5×T,

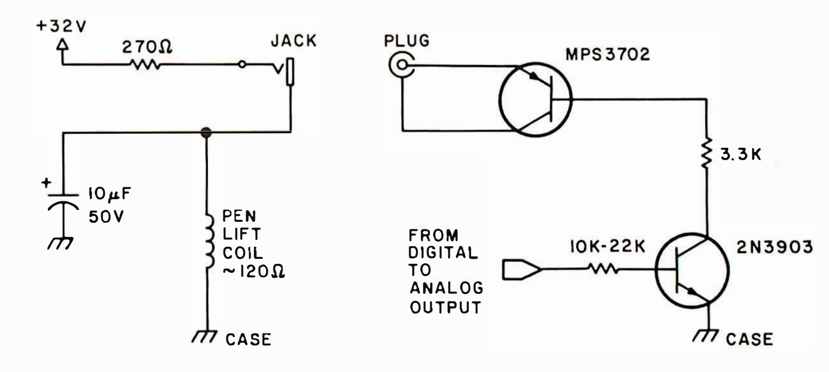


Figure 2: Pen lift circuit for use with digital-to-analog converter driver. The PNP transistor serves as switch; NPN driver transistor amplifies low-level input for high-voltage switch.

where K5 is the size factor. If K5 is -0.01, G will range from 1 to 0 during each plot. That means the picture will start out full-size, and shrink to a point just as the plot finishes. If K5 is 0, there will be no change in size.

Use of String Variables

Some plots take many points; I have allowed for 3000, or 1500 X,Y pairs. A floating-point representation would need 15,000 bytes of storage. That is more than I have, so I converted each variable to character format and stored the results as a character string, 1 byte per coordinate instead of 5. The function CHR$ will convert a floating-point number between 0 and 255 to the character format needed for strings. The ASC function will perform the reverse operation. The program scales X and Y to a positive or negative number (you must pick sizes and distances to keep this number within the range of -128 to +127 units, or 1/K1th of that amount in "real space"). This number is biased up by 128 (has 128 added to it), which is subtracted out when the stored number is recovered.

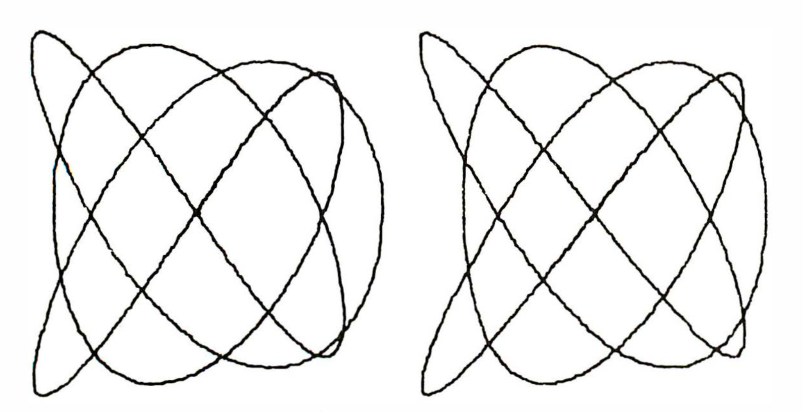


Figure 3: Plot of Lissajous pattern produced by BASIC program of listing 1, driving an analog recorder. Parameters follow in the order requested by the program. For X: cycles=3, phase=0, size=8, position=0; for Y: cycles=8, phase=0, size=8, position=0; for Z: cycles=5, phase=0, size=8, position=30, linear=0; size factor=0.

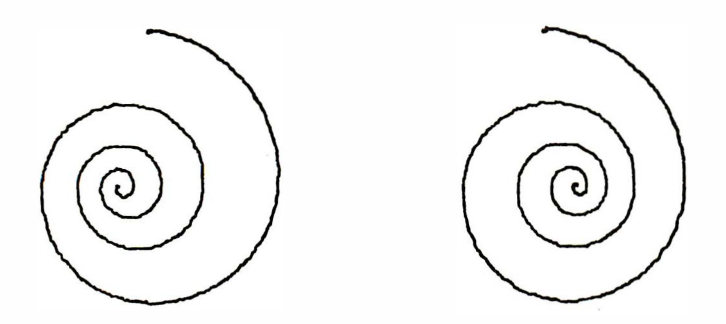


Figure 4: Spiral plot. Parameters in order are, for X: cycles=4, phase=0, size=8, position=0; for Y: cycles=8, phase=90, size=8, position=0; for Z: cycles=0, phase=0, size=0, position=30, linear=0.5; size factor= −0.01.

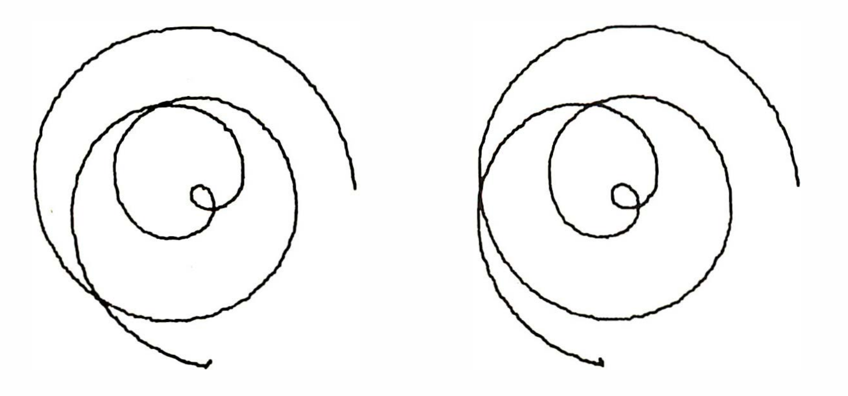


Figure 5: Plot with cardioid. Parameters are, for X: cycles=3.25, phase=0, size=9, position=0; for Y: cycles=3.25, phase=90, size=9, position=0; for Z: cycles=0, phase=0, size=0, position=30, linear=0.3; size factor= −0.03.

Miscellany

Before each plot begins, there is a pause to allow the pen to be set (with the positioning controls) to a point midway between the 2 pictures that will result. One run plots both pictures, the pen lifting as necessary. You will need some type of circuit to allow one analog output to operate the pen lift; mine is shown in figure 2.

Lines 840 thru 860 in listing 1 are a little feedback "circuit" that adjusts the step size in T (the parameter that runs from 1 to 100 during a plot) to maintain about 2 resolution elements of step size on the final plot. If the difference between the current and the last positions of the pen is larger than 2, the step size decreases. If the difference is less than 2, the step size increases. Rather than computing the square root of the sum of the squares of X and Y steps to get the actual step size, I merely summed the absolute values of the step sizes, which is close enough and much faster. This saves time that would otherwise be wasted plotting the same point over and over.

Even so, this is a very slow program. A plot with 6 loops in it takes about 10 minutes to store. Then a picture is plotted, and you must wait the same length of time for the second picture to be plotted. Practical production of 3-dimensional motion pictures requires a faster program.

Suitable lenses can be bought from the American Science Center, 5700 Northwest Hwy, Chicago IL 60646. The stock number is 95-697, which gets you a *pair* of lenses 23 mm in diameter and having a focal length of 136 mm (that gives a Z0 of 5.35 inches). The price is $2.70. Cash orders require a minimum of $5.00 and a flat handling charge of $1.00, so you will want to order with a friend or get something else from this very interesting catalog. Edmund Scientific Co, 300 Edscorp Bldg, Barrington NJ 08007 also carries these items. ■

Curve Fitting with Your Computer

Fred R Ruckdeschel
773 John Glenn Blvd
Webster NY 14580

This article is dedicated to the small system users who are faced with multiple variable data tables and who have a desire to curve fit (regress) these data into simple functional forms. The basic software problems facing such users are:

1. The powerful general purpose statistical packages available on the large computers are often not in source code (eg: BASIC or FORTRAN) for translation to a microcomputer language.
2. If the packages are available, they are often very complicated to use. There is a human language barrier.
3. The large machine software may not be directly compatible with translation to a small machine language (eg: there may be calls for matrix inversions which are not internal functions in the small system).
4. There are limitations in the types of functions fitted (eg: polynomials only) in multiple dimensions.

In the following sections we will discuss an approximate approach to the *least squares* fitting of multiple-dimension data. The technique presented depends only on the availability of a good one-dimensional curve fitting routine and requires some bookkeeping on the part of the user. Admittedly, the approach leads to statistical fits which are not optimal, but the ease of use and versatility of the method strongly counter this negative feature. An example will be given which quantitatively indicates the magnitude of the shortfall of the fit; the results are encouraging.

A significant advantage to the method to be discussed is that it is *simple.* If users understand what their one-dimensional curve fitting routine does, or at least understand how to use it, then the conceptual and practical extension to many dimensions is relatively easy.

For those who have had little experience with regressing data into functional forms, we will first consider parabolic (second order polynomial) approximations to one-dimensional data using a fairly straightforward mathematical analysis. The analysis results will then be converted into a simple computer program which will in turn be used to treat a noisy two-dimensional data set consisting of 121 data points. *[Noise results from the random fluctuation of experimental data. . . .***BWL***]* This data will be collapsed down to a set of nine coefficients belonging to the equations which represent a two-dimensional polynomial fit to the data. Extension to more dimensions will be apparent after this exercise.

Least Squares Fit of a Parabola

Although the mathematics presented in this section is reasonably simple, there are some readers who may not enjoy it. Those people may advance to the next section without great loss. For those interested in Nth order polynomial fits, see *BASIC Programming for Scientists and Engineers* by

About the Author

Dr Ruckdeschel is a principal scientist at the Xerox Corporation in Webster, New York, where he has been employed for the past 11 years. During this time he has been involved in physics and management. Recently he has turned his interests to microcomputers for both data acquisition and personal use. His hobbies include sailing, woodworking, digital electronics, programming, and haunting computer stores.

Listing 1: BASIC program for calculating a least squares parabolic fit to any data set having more than three points.

```
30 PRINT "LEAST SQUARES CURVE FIT ROUTINE"
40 PRINT\PRINT
50 PRINT "THIS PROGRAM CALCULATES A PARABOLIC "
60 PRINT "LEAST SQUARES FIT TO A GIVEN DATA SET. "
70 PRINT
80 PRINT "INSTRUCTIONS"
90 PRINT "------------"
100 PRINT
110 PRINT "THE NUMBER OF DATA COORDINATES PROVIDED "
120 PRINT "MUST BE GREATER THAN THREE. OTHERWISE, A "
130 PRINT "DIVIDE BY ZERO ERROR MAY RESULT."
140 PRINT
150 PRINT "INPUT THE NUMBER OF DATA POINTS: ",
160 INPUT I
```

Listing 1 continued on page 152

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Circle 315 on inquiry card.

Listing 1 continued:

```
170 IF I<3 THEN GOTO 110
180 DIM X(I),Y(I)
190 PRINT
200 PRINT "THERE ARE TWO INPUT OPTIONS. ONE (1) "
210 PRINT "INPUTS THE DATA POINTS IN COORDINATE "
220 PRINT "PAIRS, AND THE OTHER (2) ALLOWS ONE TO "
230 PRINT "FIRST INPUT THE INDEPENDENT VARIABLE "
240 PRINT "VALUES, LATER FOLLOWED BY THE DEPENDENT "
250 PRINT "WHICH MODE DO YOU DESIRE? (1 OR 2): ",
260 INPUT Z
270 IF Z=2 THEN GOTO 300
280 IF Z=1 THEN GOTO 390
290 GOTO 250
300 FOR M=0 TO I-1
310 PRINT M+1,
320 INPUT X(M)
330 NEXT M
340 FOR M=0 TO I-1
350 PRINT M+1,
360 INPUT Y(M)
370 NEXT M
380 GOTO 430
390 FOR M=0 TO I-1
400 PRINT M+1,
410 INPUT X(M),Y(M)
420 NEXT M
430 REM BEGINNING OF LEAST SQUARE CALCULATION
440 A0=1\A1=0\A2=0\A3=0\A4=0
450 REM U,V,W ARE THE DESIRED COEFFICIENTS
460 U=0\V=0\W=0
470 D=0
480 FOR M=0 TO I-1
490 A1=A1+X(M)
500 A2=A2+X(M)*X(M)
510 A3=A3+X(M)*X(M)*X(M)
520 A4=A4+X(M)*X(M)*X(M)*X(M)
530 B0=B0+Y(M)
540 B1=B1+Y(M)*X(M)
550 B2=B2+Y(M)*X(M)*X(M)
560 NEXT M
570 A1=A1/I\A2=A2/I\A3=A3/I\A4=A4/I
580 B0=B0/I\B1=B1/I\B2=B2/I
590 D=A0*(A2*A4-A3*A3)-A1*(A1*A4-A3*A2)+A2*(A1*A3-A2*A2)
600 U=B0*(A2*A4-A3*A3)+B1*(A3*A2-A1*A4)+B2*(A1*A3-A2*A2)
610 U=U/D
620 V=B0*(A3*A2-A1*A4)+B1*(A0*A4-A2*A2)+B2*(A2*A1-A0*A3)
630 V=V/D
640 W=B0*(A1*A3-A2*A2)+B1*(A1*A2-A0*A3)+B2*(A0*A2-A1*A1)
650 W=W/D
660 PRINT\PRINT\PRINT
670 PRINT "FITTED EQUATION IS: "
680 PRINT
690 PRINT "    Y= ",%8F4,U," ",
700 IF V>=0 THEN PRINT "+",
710 PRINT %8F4,V,"*X ",
720 IF W>=0 THEN PRINT "+ ",
730 PRINT %8F4,W,"*X*X"
740 REM EVALUATION OF STANDARD DEVIATION
750 S=0
760 FOR M=0 TO I-1
770 T=Y(M)-U-V*X(M)-W*X(M)*X(M)
780 S=S+T*T
790 NEXT M
800 S=S/(I-1)
810 PRINT\PRINT
820 PRINT "STANDARD DEVIATION OF FIT: ",
830 PRINT %8F4,SQRT(S)
840 PRINT\PRINT\PRINT
850 END
READY
```

W N Hubin (Prentice-Hall, Englewood Cliffs NJ, 1978).

The purpose of doing a particular one-dimensional least squares example is to show how a curve fitting routine may generally be developed using brute force (no tricks) techniques which require little deep thought, just competent algebra.

It is always possible to *exactly* fit a reasonably well-behaved data set using a carefully chosen polynomial of the proper *degree* (highest *power*). For example, if the independent continuous variable is x (eg: age), and the resultant dependent variable response is $y = f(x)$ (eg: height), it is legitimate to write (assuming that the "true" function has no poles or discontinuities):

$$y \cong f(x) = \sum_{m=0}^{M-1} a_m x^m \qquad (1)$$

To be sure that this approximation works well we may have to let M become infinitely large. However, for an I component data set, (y_i, x_i), where x_i is the particular independent variable value (eg: the age of a specific person) and y_i the particular response (corresponding height of that person), the data may be *exactly* fitted using a polynomial of degree $M-1 = I-1$.

The proof of this assertion is simple. Assume we do not know the coefficients a_m. However, for each of the I data points we have:

$$y_i = \sum_{m=0}^{I-1} a_m x_i^m \qquad (2)$$

Each y_i is known. Each x_i^m is known. There are thus I (simultaneous) equations in I unknowns (the a_m), and equation (2) may be exactly satisfied with a proper (and unique) choice of a_m values (coefficients). Thus the data is fitted exactly.

Although the above conclusion is very powerful, it lacks direct applicability in many real life statistical situations. For example, if there are 20 pieces of data containing noise, it would be a little foolish to fit a 19th degree polynomial to the data. Usually the objective is to smooth out large and noisy data sets into curves having only a few descriptive constants (coefficients). We will consider here *only* the second degree polynomial (parabolic) case:

$$y \cong f(x) = a_0 + a_1 x + a_2 x^2 \qquad (3)$$

The approximation sign is used, since we will usually not be able to fit the data exactly, given such a restriction on the

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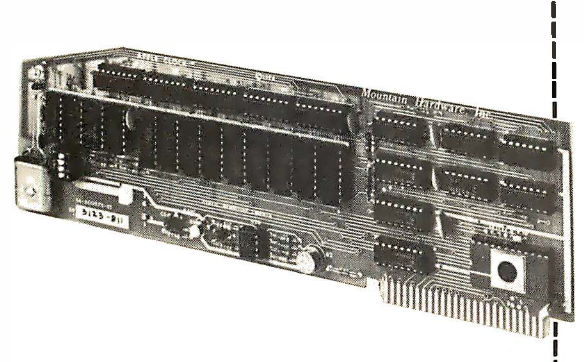
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degree of the polynomial. That is, in general $y_i \neq f(x_i)$. However, intuitively we know that there must be a best choice for a_0, a_1 and a_2, given some fitting criteria. The criteria often used is *least squares.* We define the least squares error as:

$$E(a_0, a_1, a_2) = \sum_{i=0}^{I-1} \{y_i - f(x_i)\}^2 \qquad (3a)$$

where, in this particular case,

$$f(x_i) = a_0 + a_1 x_i + a_2 x_i^2 \qquad (3b)$$

The object is to find a choice for the a_m which gives a minimum value for E. By separately taking partial derivatives of equation (3a) with respect to a_0, a_1 and a_2 we get the following three equations in the three unknowns, a_0, a_1 and a_2:

$$0 = \sum_{i=0}^{I-1} y_i - a_0 - a_1 x_i - a_2 x_i^2 \qquad (4a)$$

$$0 = \sum_{i=0}^{I-1} \{y_i - a_0 - a_1 x_i - a_2 x_i^2\} x_i \qquad (4b)$$

Listing 2a: Sample run of listing 1 in which the data was created using y=x.

```
RUN



LEAST SQUARES CURVE FIT ROUTINE


THIS PROGRAM CALCULATES A PARABOLIC
LEAST SQUARES FIT TO A GIVEN DATA SET.

INSTRUCTIONS
------------

THE NUMBER OF DATA COORDINATES PROVIDED
MUST BE GREATER THAN THREE. OTHERWISE, A
DIVIDE BY ZERO ERROR MAY RESULT.

INPUT THE NUMBER OF DATA POINTS: ?10

THERE ARE TWO INPUT OPTIONS. ONE (1)
INPUTS THE DATA POINTS IN COORDINATE
PAIRS, AND THE OTHER (2) ALLOWS ONE TO
FIRST INPUT THE INDEPENDENT VARIABLE
VALUES, LATER FOLLOWED BY THE DEPENDENT
WHICH MODE DO YOU DESIRE? (1 OR 2): ?1
 1?0,0
 2?1,1
 3?2,2
 4?3,3
 5?4,4
 6?5,5
 7?6,6
 8?7,7
 9?8,8
 10?9,9


FITTED EQUATION IS:

   Y=     .0000 +  1.0000*X +    .0000*X*X


STANDARD DEVIATION OF FIT:    .0000



READY
```

Listing 2b: Sample run similar to listing 2a, but with $y=x^2$.

```
RUN



LEAST SQUARES CURVE FIT ROUTINE


THIS PROGRAM CALCULATES A PARABOLIC
LEAST SQUARES FIT TO A GIVEN DATA SET.

INSTRUCTIONS
------------

THE NUMBER OF DATA COORDINATES PROVIDED
MUST BE GREATER THAN THREE. OTHERWISE, A
DIVIDE BY ZERO ERROR MAY RESULT.

INPUT THE NUMBER OF DATA POINTS: ?10

THERE ARE TWO INPUT OPTIONS. ONE (1)
INPUTS THE DATA POINTS IN COORDINATE
PAIRS, AND THE OTHER (2) ALLOWS ONE TO
FIRST INPUT THE INDEPENDENT VARIABLE
VALUES, LATER FOLLOWED BY THE DEPENDENT
WHICH MODE DO YOU DESIRE? (1 OR 2): ?1
 1?1,1
 2?2,4
 3?3,9
 4?4,16
 5?5,25
 6?6,36
 7?7,49
 8?8,64
 9?9,81
 10?10,100


FITTED EQUATION IS:

   Y=     .0000 +    .0000*X +   1.0000*X*X


STANDARD DEVIATION OF FIT:    .0000



READY
```

$$0=\sum_{i=0}^{I-1}\left\{y_i-a_0-a_1x_i-a_2x_i^2\right\}x_i^2 \quad (4c)$$

These simultaneous equations can be solved using Cramer's Rule (see texts on matrix algebra) to give:

$$a_0=\{B_0(A_2A_4-A_3^2)+B_1(A_3A_2-A_1A_4)+B_2(A_1A_3-A_2^2)\}/D \quad (5a)$$

$$a_1=\{B_0(A_3A_2-A_1A_4)+B_1(A_0A_4-A_2^2)+B_2(A_2A_1-A_0A_3)\}/D \quad (5b)$$

$$a_2=\{B_0(A_1A_3-A_2^2)+B_1(A_1A_2-A_0A_3)+B_2(A_0A_2-A_1^2)\}/D \quad (5c)$$

where:

$$D=A_0(A_2A_4-A_3^2)-A_1(A_1A_4-A_3A_2)+A_2(A_1A_3-A_2^2) \quad (5d)$$

and:

$$A_0=1$$

$$A_s=\sum_{i=0}^{I-1}x_i^s/I$$

$$B_s=\sum_{i=0}^{I-1}y_ix_i^s/I$$

These equations are encoded into the program shown in listing 1. Listing 2a shows a sample run in which the relation $y=x$ was used to create the data. The program correctly interpreted the data and returned $y=x$ as the fitted function. In this example there was no x^2 term. Listing 2b demonstrates a similar test run, but this time using $y=x^2$ to create the data. Again, the program returns the proper coefficients.

Listing 2c displays a least squares fit to data generated using the function $y=x+\epsilon$, where ϵ flips back and forth between +1 and −1; very noisy data. The regression program indicates the fitted functional form to be linear with a first power (linear) coefficient near unity, and with a standard deviation approximately equal to ϵ. When the same data sets are run through a standard Nth order regression routine, the coefficient values obtained were approximately the same as shown in listings 2a and 2b. However, significantly different coefficients are obtained for the case corresponding to listing 2c. The fitted equation given by the

Listing 2c: Least squares fit to a noisy line: $y=x+\epsilon$.

```
RUN



LEAST SQUARES CURVE FIT ROUTINE


THIS PROGRAM CALCULATES A PARABOLIC
LEAST SQUARES FIT TO A GIVEN DATA SET.

INSTRUCTIONS
------------

THE NUMBER OF DATA COORDINATES PROVIDED
MUST BE GREATER THAN THREE. OTHERWISE, A
DIVIDE BY ZERO ERROR MAY RESULT.

INPUT THE NUMBER OF DATA POINTS: ?10

THERE ARE TWO INPUT OPTIONS. ONE (1)
INPUTS THE DATA POINTS IN COORDINATE
PAIRS, AND THE OTHER (2) ALLOWS ONE TO
FIRST INPUT THE INDEPENDENT VARIABLE
VALUES, LATER FOLLOWED BY THE DEPENDENT
WHICH MODE DO YOU DESIRE? (1 OR 2): ?1
 1?0,-1
 2?1,2
 3?2,1
 4?3,4
 5?4,3
 6?5,6
 7?6,5
 8?7,8
 9?8,7
 10?9,10


FITTED EQUATION IS:

   Y=   -.2727 +  1.0606*X +    .0000*X*X


STANDARD DEVIATION OF FIT:   1.0380


READY
```

Poole-Borchers regression is (when run on North Star BASIC, *Release 2, Version 3*):

$$y = 0.34545452 + 0.8015152x + 0.02727268x^2 \qquad (6)$$

These coefficients have some interesting repeating number sequences, but that is not a good reason to condemn them. However, using the above regression equation and calculating the standard deviation between the fit predictions and the input data gives a standard deviation of 1.0869, as compared with a value of 1.0380 obtained using the Cramer's Rule algorithm shown in listing 1. It is apparent that the program given in this article provides a better fit than that of Poole and Borchers. The discrepancy is probably due to the errors which occur when the square is evaluated using $x \wedge 2$ (as in Boolean-Borchers algorithm) instead of $x * x$, which is more accurate.

It is also interesting to note that although the two sets of coefficients obtained from the two different algorithms are quite disparate, the fits (as measured by the standard deviation) are similar. When data is very noisy, a range of equations may fit the data to similar precision; the polynomial coefficients obtained should not be treated as significant to very many decimal places.

```
X= 0

   Y        Z
 -----    -----
  .0000  -1.8770
  .1000  -1.4777
  .2000  -1.2124
  .3000   -.6021
  .4000   -.1597
  .5000    .6029
  .6000   1.4153
  .7000   2.1712
  .8000   3.0442
  .9000   4.0435
 1.0000   5.0899
X= .1

   Y        Z
 -----    -----
  .0000  -2.1727
  .1000  -1.6902
  .2000  -1.3769
  .3000   -.7970
  .4000   -.3682
  .5000    .3858
  .6000    .9666
  .7000   1.8338
  .8000   2.6107
  .9000   3.7345
 1.0000   4.6834
X= .2

   Y        Z
 -----    -----
  .0000  -2.2148
  .1000  -1.9373
  .2000  -1.5422
  .3000  -1.0575
  .4000   -.4524
  .5000    .1243
  .6000    .8916
  .7000   1.6626
  .8000   2.3359
  .9000   3.2565
 1.0000   4.3737
X= .3

   Y        Z
 -----    -----
  .0000  -2.5664
  .1000  -2.2315
  .2000  -1.7197
  .3000  -1.1910
  .4000   -.6178
  .5000   -.0026
  .6000    .5297
  .7000   1.3222
  .8000   2.2567
  .9000   3.1909
 1.0000   4.0585
X= .4

   Y        Z
 -----    -----
  .0000  -2.6813
  .1000  -2.4391
  .2000  -2.0129
  .3000  -1.3930
  .4000   -.8603
  .5000   -.3129
  .6000    .5422
  .7000   1.2312
  .8000   2.0625
  .9000   3.0280
 1.0000   4.0109
X= .5

   Y        Z
 -----    -----
  .0000  -2.9732
  .1000  -2.5161
  .2000  -2.2357
  .3000  -1.5418
  .4000  -1.0049
  .5000   -.4632
  .6000    .3524
  .7000   1.1281
  .8000   2.0464
  .9000   2.9854
 1.0000   4.0366
X= .6

   Y        Z
 -----    -----
  .0000  -3.1383
  .1000  -2.8093
  .2000  -2.2651
  .3000  -1.8521
  .4000  -1.1915
  .5000   -.4113
  .6000    .3657
  .7000   1.0686
  .8000   2.1812
  .9000   3.0908
 1.0000   4.3529
X= .7

   Y        Z
 -----    -----
  .0000  -3.3040
  .1000  -2.8519
  .2000  -2.4128
  .3000  -1.8814
  .4000  -1.2392
  .5000   -.5648
  .6000    .2919
  .7000   1.0987
  .8000   2.1666
  .9000   3.3581
 1.0000   4.5745
X= .8

   Y        Z
 -----    -----
  .0000  -3.5062
  .1000  -3.0467
  .2000  -2.6141
  .3000  -2.1694
  .4000  -1.5072
  .5000   -.6622
  .6000    .3193
  .7000   1.3245
  .8000   2.4790
  .9000   3.5361
 1.0000   4.8953
X= .9

   Y        Z
 -----    -----
  .0000  -3.7272
  .1000  -3.3490
  .2000  -2.8361
  .3000  -2.3384
  .4000  -1.5902
  .5000   -.7453
  .6000    .2876
  .7000   1.4160
  .8000   2.6644
  .9000   3.9098
 1.0000   5.4958
X= 1

   Y        Z
 -----    -----
  .0000  -3.8650
  .1000  -3.5359
  .2000  -3.0804
  .3000  -2.4238
  .4000  -1.5126
  .5000   -.5842
  .6000    .3587
  .7000   1.7134
  .8000   3.0229
  .9000   4.4793
 1.0000   6.0015
READY
```

Listing 3: Two-dimensional data set containing noise. This set was created in a well-defined way such that the fit obtained could be compared against the original function.

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This is one of the dangers in curve fitting and placing great value on the results, especially when mathematically exact algorithms can be waylaid by calculation error.

In the next section we will consider how to use the one-dimensional least squares routine for fits in many dimensions.

Parabolic Fits in Many Dimensions

To examine how the one-dimensional least squares routine may be used (in approximation) in many dimensions, we will first consider the two-dimensional case.

Let x_i and y_i be the independent variables, and z_i be the dependent variable. The parabolic fit desired is:

$$z_i = f(x_i,y_i) = b_0(x_i) + b_1(x_i)y_i + b_2(x_i)y_i^2 \quad (7)$$

where:

$$b_0 = a_{00} + a_{10}x_i + a_{20}x_i^2 \quad (8a)$$

$$b_1 = a_{01} + a_{11}x_i + a_{21}x_i^2 \quad (8b)$$

$$b_2 = a_{02} + a_{12}x_i + a_{22}x_i^2 \quad (8c)$$

Ideally we would choose the nine $a_{\ell m}$ coefficient values such that

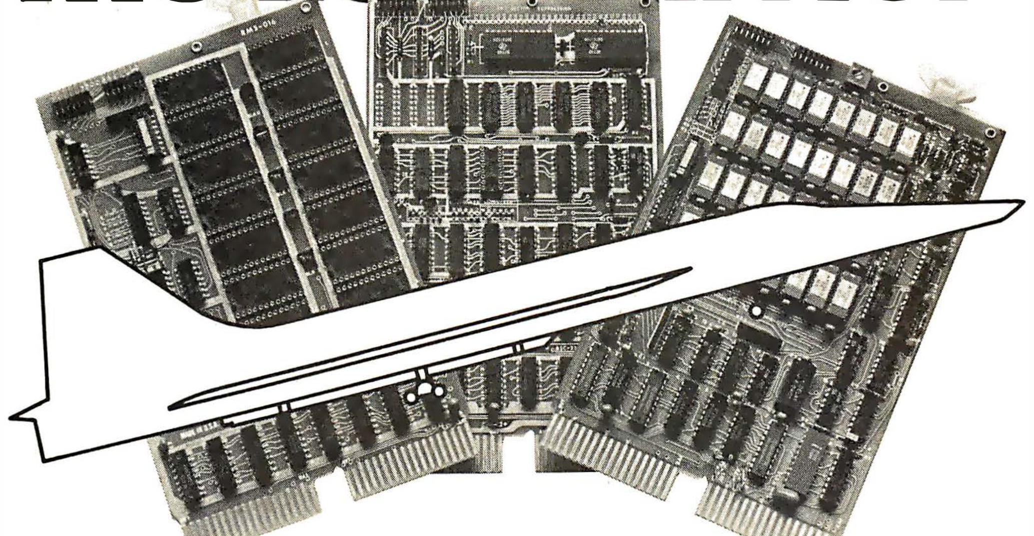
$$\sum_{i=0}^{I-1} \{z_i - f(x_i, y_i)\}^2$$

is minimized. In other words, we wish to minimize the sums of the squares of the distances between predicted and actual data points. However, if the data is arranged in a tabular form, such as shown in listing 3, a quasi-least squares fit can be obtained one dimension at a time.

The way this is done is that for *each* x_i we regress z_i (the dependent variable) against y_i (the independent variable) to obtain a least squares set of $b_0(x_i)$, $b_1(x_i)$ and $b_2(x_i)$. Next, we treat $b_0(x_i)$ as a dependent variable and regress against x_i (the remaining independent variable) to get a_{00}, a_{01} and a_{02}. The same is done for $b_1(x_i)$ and $b_2(x_i)$.

For the data shown in listing 3, the first regression step yields the $b_\ell(x_i)$ values given in table 1. Each coefficient column in table 1 is then regressed against x_i to give the nine coefficients listed in table 2. These coefficients may be used with equations (8a), (8b) and (8c) to obtain the regression indicated by equation (7).

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Because we did the regression in two steps, the least squares criteria taken as a whole haven't been satisfied. Thus the coefficients obtained are not optimal, as will be seen shortly.

It should be noted in passing that the blocks of data (for each x_i) are equal in length. This is not a requirement for validity of the technique. What is necessary is that there be at least three independent data points in each x_i block. Otherwise D in equation (5d) becomes 0, and a divide error will result. Also observe that the x_i and y_i increments need not be equal or uniform. Few restrictions are placed on the data.

The precision of the regression fit may be assessed using the standard deviation associated with the difference between the predicted data values and the actual data. This gives 0.23, or roughly 3 percent accuracy, which is encouraging.

The equation used to generate the noisy two-dimensional data was:

$$z = 6x^2y^2 - 3xy^2 + 4y^2 - 2x + 3y - 1.9 + 0.2\,(RND(0) - 0.5) \qquad (9)$$

The standard deviation of the noise term is 0.06. Thus the 2 step fitting procedure is not as good as it could possibly be; 1 percent accuracy could be obtained using the nonrandom part of equation (9); a better fit.

It is left to the reader to relate the coefficients shown in table 2 to their corresponding elements in equation (9). Observe that the coefficients correspond, but with differences often greater than that indicated by the standard deviation.

Extension of the method of stepping through the regression, one dimension at a time, is simple. It is done by creating a hierarchy of "data" tables. For a three-dimensional problem involving the regression of $\mathbf{U} = U(x, y, z)$, tables would be created in which x and y are temporarily held constant, and z varied. The three first level coefficients would then be functions of x and y. Next, tables of those three coefficients would be compiled in which x is held constant and y varied. This would lead to nine coefficients, each being a function of x. The third level regression would be against x and give 27 coefficients.

I have had opportunity in the past to apply this technique to a horrendous engineering measurement problem involving five independent variables (several thousand measured data points). Four of the dimensions were parabolically fitted, one was approximated using a fourth order polynomial. (Note that there is a freedom in the *form* of the fitting function applied in each dimension.) In this application, the data was regenerated to a standard deviation of better than 3 percent, which was more than sufficient. Although the fit was not optimal, the savings in programming time and sanity more than compensated for whatever error occurred.

Conclusions

The multidimensional curve fitting technique presented in this article depends only on the existence of a good one-dimensional least squares routine. The form of the least squares fitting function can be different for each dimension regressed. Often the form can be chosen by either an understanding of the causal relationships, or by simply scanning the data.

The user who has some familiarity with algebra and calculus can generate a least squares fit for other functional forms using the simultaneous equation technique shown herein. Recall that the equations were obtained by considering the error to be a function of the coefficients, and partial derivatives were taken with respect to each coefficient.

In conclusion, this article presents a general technique for generating one-dimensional least squares fitting algorithms, and shows how such algorithms may be used to regress multidimensional data.■

x_i	$b_0(x_i)$	$b_1(x_i)$	$b_2(x_i)$	Standard Deviation
0.0	−1.8758	2.9021	4.0807	0.05
0.1	−2.2677	3.1672	4.2439	0.24
0.2	−2.4542	3.2702	3.9614	0.24
0.3	−2.7791	3.7056	3.5807	0.24
0.4	−2.9875	3.5408	3.8676	0.23
0.5	−3.2118	3.5623	4.0746	0.23
0.6	−3.4316	3.5360	4.5941	0.24
0.7	−3.5456	3.2876	5.2208	0.25
0.8	−3.8010	3.3066	5.8698	0.27
0.9	−4.0544	3.1017	6.9178	0.28
1.0	−4.2911	3.4786	7.4185	0.31

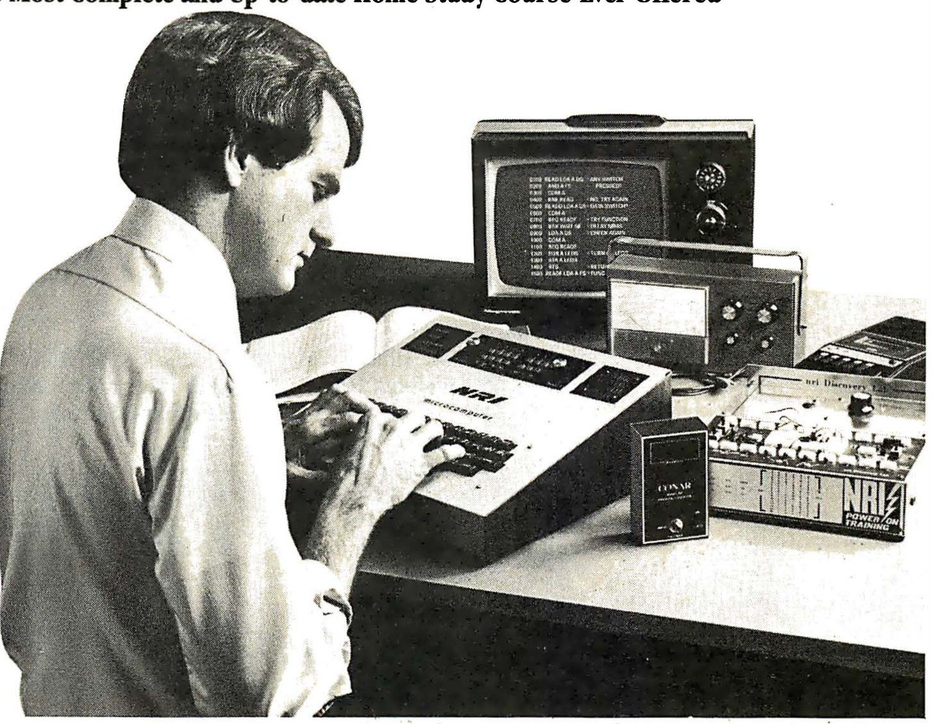
Table 1: First level regression coefficients.

$a_{\ell m}$	m \ ℓ	0	1	2	Standard Deviation
	0	−1.9433	−2.7209	0.4263	0.05
m	1	3.0110	1.8648	−1.6931	0.17
	2	4.2540	−3.6091	6.9833	0.18

Table 2: Nine regressed coefficients corresponding to equations 8a, 8b, and 8c in text.

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October 1-3
Second Annual Symposium on Small Systems, Hilton Inn, Dallas TX. The symposium will consist of a blend of paper and panel discussions with major emphasis on microcomputer applications. Both hardware and software topics presenting state-of-the-art and state-of-the-industry aspects will be included. Contact Gerald Kane, Southern Methodist University, Dallas TX 75222.

October 2-4
NEPCON Central '79, O'Hare Exposition Center, Rosemont IL. This tenth annual exhibition and conference of electronic and microelectronic packaging and production equipment will feature displays of electronic and microelectronic materials, hardware, tools, supplies and test instruments. Contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606.

October 6
Personal Computer Music Festival, Philadelphia Civic Center, Philadelphia PA. This festival will feature a daytime exhibition and fair including demonstrations; seminars and guest speakers; evening concert; and multimedia show. Contact PACS, POB 1954, Philadelphia PA 19105.

October 10
Invitational Computer Conference, Newton MA. This conference is directed to the quantity buyer, and will feature the newest developments in computer and peripheral technology. Contact B J Johnson and Associates, 2503 Eastbluff Dr, Suite 203, Newport Beach CA 92660.

October 14-17
International Data Processing Conference and Business Exposition, Town and Country Hotel, San Diego CA. Contact Data Processing Management Association, 505 Busse Highway, Park Ridge IL 60068.

October 15-18
Sixth Information Management Exposition and Conference, New York Coliseum, New York NY. Contact Clapp and Poliak Inc, 245 Park Ave, New York NY 10017.

October 15-19
Distributed Processing, George Washington University, Washington DC. This course is designed for engineers, computer scientists and data processing managers who need a better working knowledge of distributed processing techniques as applied to complex computing problems. Contact Continuing Engineering Education, George Washington University, Washington DC 20052.

October 15-19
CPEUG 79, San Diego CA. This is the fifteenth meeting of the Computer Performance Evaluation Users Group sponsored by the National Bureau of Standards. Contact Judith G Abilock, The MITRE Corp, Metrek Division, 1820 Dolley Madison Blvd, McLean VA 22102.

October 16-18
Understanding and Using Computer Graphics, Washington DC. This course is for people who are now using, or making decisions about using computer graphics and its role in their organization. It will describe computer graphics, explain what hardware and software systems are available and give cost and performance comparisons. Contact Frost and Sullivan, 106 Fulton St, New York NY 10038.

October 17-18
The Western Computer Conference, The Calgary Convention Centre, Calgary, Alberta. Some of the session topics to be discussed are distributed data processing in the natural resources industries; growth of the original equipment manufacturers (OEM) market in Canada's western provinces; transborder data flows, national and international; and use of graphics in seismographic and geophysical modeling. Contact Janet Glover, Conference Co-ordinator, Whitsed Publishing Ltd, 2 Bloor St W, Suite 2504, Toronto, Ontario CANADA M4W 3E2.

October 20-21
Fourth Annual Tidewater Hamfest-Computer Show-Flea Market, Cultural and Convention Center, Norfolk VA. Contact TRC, POB 7101, Portsmouth VA 23707.

October 21-23
New York State Association for Educational Data Systems Annual Conference, Granit Hotel, Kerhonksen NY. The theme of this conference is Instructional Computing — Hardware/Software/Courseware. Contact Mary E Heagney, 9201 Shore Rd, Brooklyn NY 11209.

October 22-23
Minicomputer Technology, George Washington University, Washington DC. This course will cover internal operation, programming, and performance of minicomputers with examples drawn from current systems. Contact Continuing Engineering Education, George Washington University, Washington DC 20052.

October 22-24
The Association of Computer Programmers and Analysts Ninth Annual Conference, Washington DC. The general theme of this conference is Preparing Today for Tomorrow's New Technologies. Suppliers of software packages and computer services have been invited to describe and present their products in a series of structured presentations. Other sessions will cover trends in system technology and new methodologies for sharpening the professional skills of both systems analysts and programmers. Contact DBD Systems Inc, 1500 N Beauregard St, Alexandria VA 22311.

October 22-24
Computers in Aerospace Conference II, Hyatt House Hotel, Los Angeles CA. The conference theme, Computer Technology for Space and Aeronautical Systems in the Eighties, will be carried out by a series of panels, invited presentations, and contributed papers which will bring computer system technologists together with specialists in the application of embedded computers in space and aeronautics. Contact American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York NY 10019.

October 22-25
ISA/79, O'Hare Exposition Center, Chicago IL. The conference theme, Instrumentation for Energy Alternatives, will emphasize current practices in instrumentation design and implementation. Contact Instrument Society of America, 400 Stanwix St, Pittsburgh PA 15222.

October 22-26
Integrated Circuits for Signal Processing, University of Waterloo, Waterloo, Ontario, Canada. This course is designed to meet the needs of electronic design engineers, supervisory-level engineers and technical managers who are involved in hardware-oriented programs and desire an up-to-date knowledge of modern integrated circuits for signal processing. Contact ICSP 1979, Electrical Engineering Dept, University of Waterloo, Waterloo, Ontario, CANADA W2L 3G1.

October 22-26
Pascal Programming for Mini and Microcomputers, Ramada Inn, Worburn MA. Sponsored by the Polytechnic Institute of New York and the Institute for Advanced Professional Studies, this workshop will include application examples, lectures, informal sessions with the instructor, as well as individual and group programming sessions. Contact Professor Donald D French, Institute for Advanced Professional Studies, One Gateway Center, Newton MA 02158.

October 24-26
Design and Selection of Minicomputer Systems, George Washington University, Washington DC. The course will cover all aspects of systems implementation using microcomputers: hardware selection and configuration, software design and programming, peripheral equipment, interfacing with special equipment, and operations management. Contact Continuing Engineering Education, George Washington University, Washington DC 20052.

October 28-30
The Tenth North American Computer Chess Championship, Detroit Plaza, Detroit MI. Sponsored by the Association for Computing Machinery, this is a 4 round Swiss-style tournament with the first 2 rounds to be played on October 28th (1 PM and 7:30 PM), 1 on

October 29th (7:30 PM) and the last round on Tuesday, October 30th (7:30 PM). Contact Monroe Newborn, McGill University, School of Computer Science, 805 Sherbrooke St W, Montreal PQ, CANADA H3A 2K6.

October 29

Modern Software Development Techniques for Managers, George Washington University, Washington DC. The purpose of this course is to provide managers who are involved with in-house software development, or for those who contract out software needs, with the techniques of modern software development. Contact Continuing Engineering Education, George Washington University, Washington DC 20052.

October 29 - November 2

Applied Interactive Computer Graphics, University of Maryland, College Park MD. This course is designed to cover the most important facets of graphics that are necessary to develop general graphic applications. Systems considerations are stressed, including configuration selection criteria and the pros and cons of off-the-shelf software. The most important factors and techniques are described for hardware, software and geometric modeling. Contact UCLA Extension, 10995 Le Conte Ave, Los Angeles CA 90024.

October 30-31

Eleventh Anniversary Professional Training Conference, Hyatt Regency — O'Hare, Chicago IL. The conference theme, Exceleration: Expanding the Training Spectrum...for Today and Tomorrow, will deal with such topics as data processing, office automation, resources from space, the economy, and a wide variety of training and management issues. Contact Advanced Systems Inc, 1601 Tonne Rd, Elk Grove Village IL 60007.

October 31 - November 1

Interface West, Anaheim Convention Center, Anaheim CA. This third annual west coast small computer and office automation systems conference and exposition will feature over 100 company exhibits and 60 conference sessions covering a variety of data processing, word processing, data communications, management hardware, software and service topics. Contact the Interface Group, 160 Speen St, Framingham MA 01701.

NOVEMBER 1979

November 1

Invitational Computer Conference, Cherry Hill NJ. See October 10th for details.

November 5-7

Thirteenth Asilomar Conference on Circuits, Systems and Computers, Asilomar Hotel and Conference Grounds, Pacific Grove CA. Contact Roger C Wood, Electrical and Computer Engineering Dept, University of California, Santa Barbara CA 93106.

November 5-8

Electronics Production Engineering Show, Kosami Exhibition Center, Seoul Korea. This international industrial exposition will be devoted to the needs of manufacturers of electronic products in Korea. Contact Expoconsul, Clapp and Poliak International Sales Division, 420 Lexington Ave, New York NY 10017.

November 6-8

Midcon/79 Show and Convention. O'Hare Exposition Center and Hyatt Regency O'Hare, Chicago IL. Contact Electronic Conventions Inc, 999 N Sepulveda Blvd, El Segundo CA 90245.

November 6-8
Institute of Electrical and Electronic Engineers (IEEE) Third International Conference on Computer Software and Applications, The Palmer House, Chicago IL. Contact IEEE Computer Society, POB 639, Silver Spring MD 20901.

November 6-8
Third Digital Avionics Systems Conference, Fort Worth TX. This conference will probe the expectations and challenges of the digital revolution in avionics systems. Contact John C Ruth, Technical Program Chairman, POB 12628, Fort Worth TX 76116.

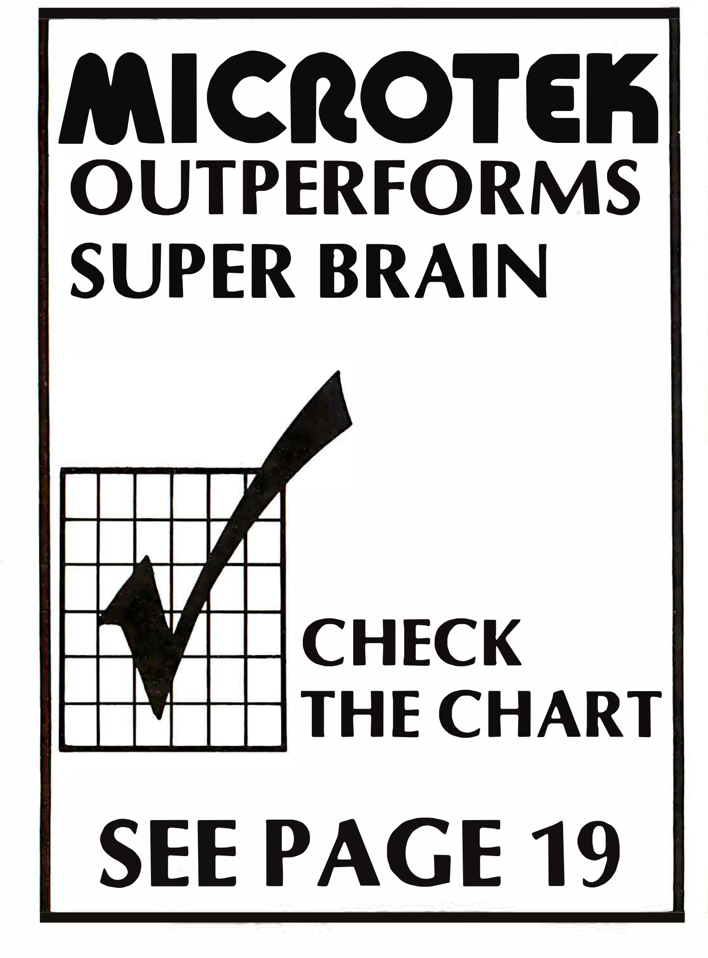
November 12-14
Computer Cryptography, The George Washington University, Washington DC. The objective of this course is to provide each participant with a working knowledge of the use of cryptography in computer applications. Contact Continuing Education, George Washington University, Washington DC. 20052.

November 14-16
International Micro and Mini Computer Conference, Astro Village, Houston TX. This conference concerns micro and mini computer systems, a survey of the range of current applications, and exploration of potential areas for future development. Emphasis will be placed on technical papers and exhibits. Contact Dr S C Lee, School of Electrical Engineering and Computer Sciences, University of Oklahoma, Norman OK 73019.

November 15
Invitational Computer Conference, Southfield MI. See October 10th for details.

November 28-30
Business and Personal Computer Sales Expo '80, Philadelphia Civic Center, Philadelphia PA. Contact Produx 2000 Inc, Roosevelt Blvd and Mascher St, Philadelphia PA 19120.

November 29-30
Metric Management Workshop, Dallas North Park Inn, Dallas TX. The workshop is designed to help personnel at all levels plan and implement a cost-effective transition to metric in their company. The sessions will cover establishing a metric plan and strategy, assigning responsibility for the transition within the existing organizational structure, and developing a sensible approach to controlling conversion costs. Contact Len Boselovic, ANMC, 1625 Massachusetts Ave NW, Washington DC 20036.



DECEMBER 1979

December 3-5
Implementing Cryptography in Data Processing and Communications Systems, New York NY. Going beyond an introduction to cryptographic systems, the seminar will stress implementation of the data encryption system (DES) and address public key implementation considerations. Contact Ms Jansen, Cryptotech, 12 State Rd, Bellport NY 11713.

December 3-5
Winter Simulation Conference, Holiday Inn, Embarcadero, San Diego CA. This conference will feature papers and panel discussions on discrete and combined (discrete and continuous) simulations. Contact Professor Robert E Shannon, University of Alabama in Huntsville, School of Science and Engineering, POB 1247, Huntsville AL 35807.

December 3-5
COMDEX '79, MGM Grand Hotel, Las Vegas NV. This conference and exposition for third party sellers of computer systems, word processing systems, peripherals and software packages and media will focus on solutions to business problems normally encountered in structuring a successful dealership and the operational aspects of the dealership from both the supplier and customer side. Contact The Interface Group, 160 Speen St, Framingham MA 01701.

December 10-12
Project Management for Computer Systems, Chicago IL. This seminar will illustrate techniques for planning, implementing, installing, and controlling projects. Contact The University of Chicago, 1307 E 60th St, Chicago IL 60637.

December 10-13
1979 Fall DECUS US Mini/Midi Symposium, San Diego CA. This symposium is an opportunity for Digital Equipment Computer users to participate in a technical exchange. Contact DECUS, One Iron Way, MR2-3, Marlboro MA 01752.

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Circle 306 on inquiry card.

Low-Level Program Optimization:

Some Illustrative Cases

James Lewis
President
Micro Logic Corp
POB 174
Hackensack NJ 07602

A program or subroutine can usually be modified so that it requires less time or space for execution.

The above observation about optimization suggests that a program or subroutine can usually be changed, so that it either runs faster or takes up less memory space, and one can often accomplish both at the same time.

Programs can be optimized for other things, such as readability, maintainability, structure, etc. This article, however, stresses optimization for time and space. If a program written for a microprocessor can be made shorter using space optimization, less memory can be used, or more functions can be packed into the same memory. Either way, optimization pays off. If the program can be made to run faster, more functions can be performed in the same amount of time. In fact, optimization can make the difference between whether or not an application of a microprocessor is feasible.

A distinction can be made between 2 types of optimization techniques. One is code optimization and the other is algorithmic optimization. Code optimization involves concentrating on the structure of the actual code on a low level. This includes such operations as reordering instruction sequences and combining 2 instructions into 1 instruction. Algorithmic optimization is on a high level and involves rethinking the whole approach to a program or section of a program. This is much more general and powerful than code optimization, but its rules cannot easily be written down. It takes an experienced programmer or system designer to perform algorithmic optimization effectively. Examples of code optimization tricks will be given below.

In the event that a program cannot be modified so that both space and time are lessened, there is usually the possibility of a trade-off. That is, if space is decreased, time will increase, and if time is decreased, space will increase. Only the particular situation can determine which route to take.

How much optimization is possible? Experience has shown that upon careful analysis a first draft program can typically be reduced by as much as 50 percent or more in terms of memory space. Time optimization is another story. Some programs can be accelerated at the expense of using more memory. However, significant time reductions can usually be made at little expense of memory; in fact, there may even be a savings of memory.

How much optimization should be done? In the process of optimizing a program, it becomes harder and harder to discover more program reductions. How far one should go depends on the relation between the cost of the programmer's time and the savings due to optimizations.

The process of optimization has fringe benefits. In analyzing a program, the programmer gains a clearer picture of how it works and often finds bugs. It is clear that a good software engineer should spend some time optimizing code.

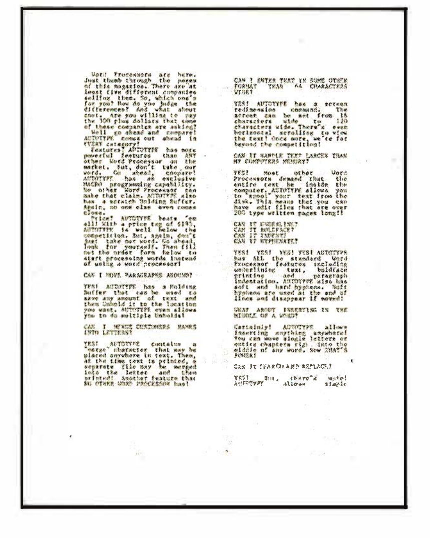
Before discussing the techniques themselves, it should be pointed out that not all of the ideas mentioned are always beneficial. For example, one of the tricks reduces the elegance of the subroutine structure. If this type of elegance is desired, perhaps the trick should not be used.

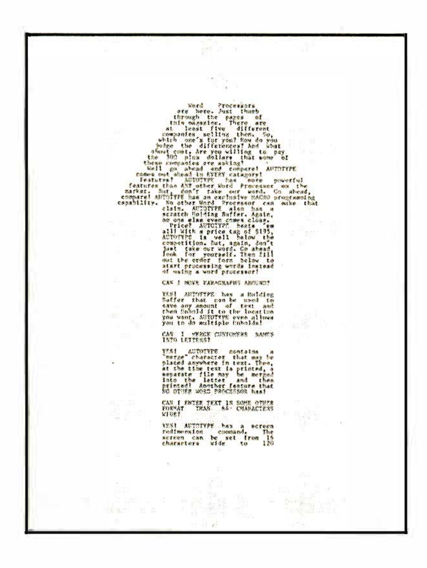
The ideas presented are applicable to most microprocessors. They are intended for use on assembly language programs, although some of them apply to other languages. An English assembly language is used in the examples for generality. Note that the command CALL SUB means push the return address on the stack and then jump to the subroutine.

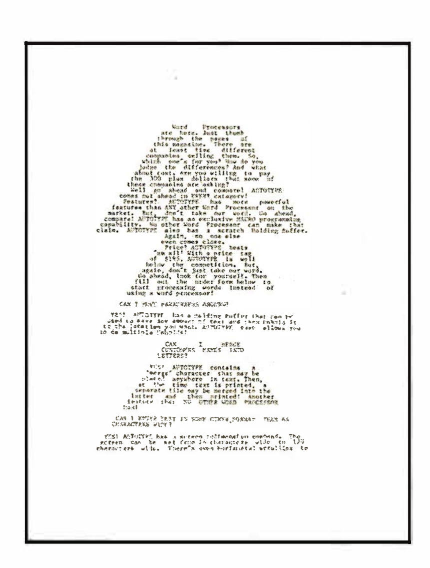
The code optimization examples will usually be presented in the following format:

About the Author

James Lewis is president of Micro Logic Corp. His company has done microprocessor applications ranging from laser-beam controllers to chemical-analyzer systems. Their development lab is in Hackensack NJ.







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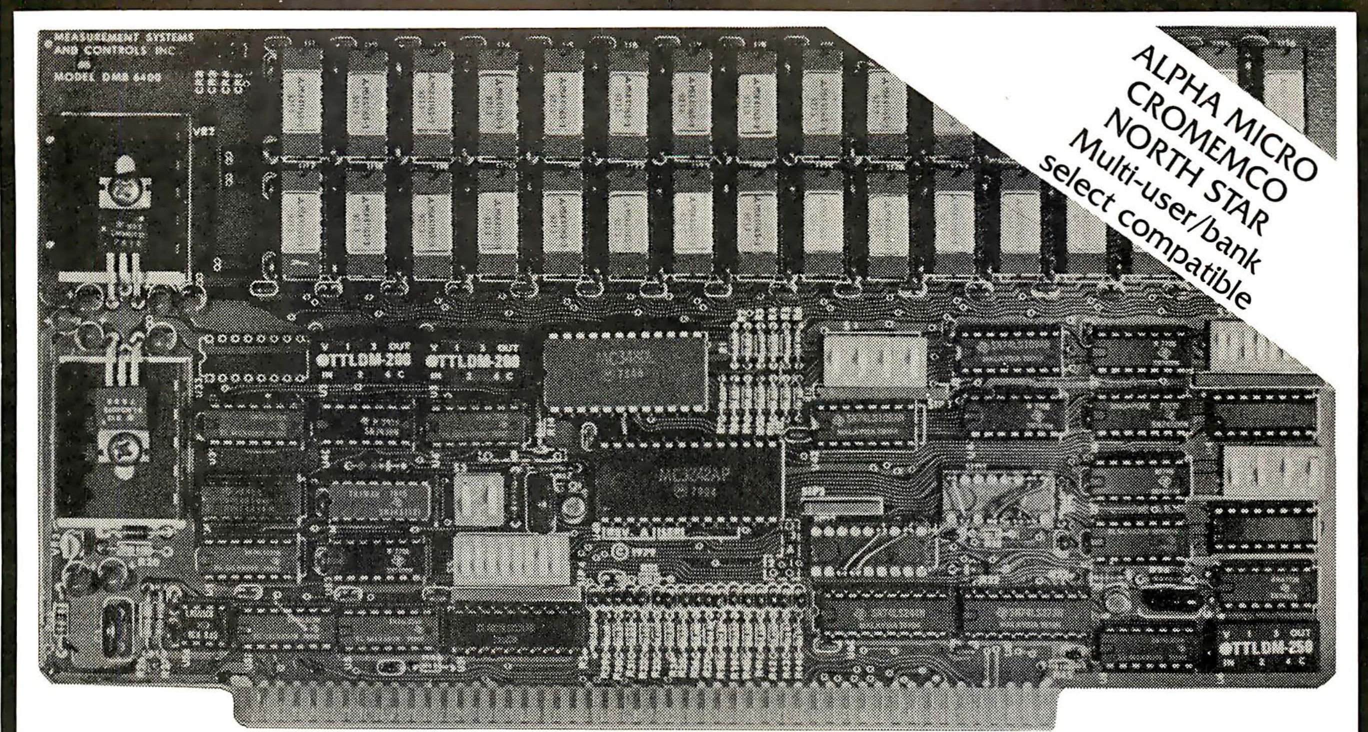
Title	
Description of optimization technique	
Example of program before optimization	The same program shown after optimization

Returning a call	
If a call to a subroutine is followed by a return instruction, the 2 instructions can be replaced by a jump to the subroutine.	
CALL ARNOLD RETURN	JUMP ARNOLD

Endless subroutine	
If the last line of a subroutine is a jump to another subroutine, as in the first example, one can often position the subroutine which is jumped to directly below the jump instruction, so that the jump instruction is not needed.	
JUMP BETTY CINDY: LOAD X . . . RETURN BETTY: STORE X . . . RETURN	BETTY: STORE X . . . RETURN CINDY: LOAD X . . . RETURN

Expanded loop	
To increase the speed of an important loop, one can expand the loop either partially or wholly at the expense of space. This works best when the loop has a fixed number of iterations that is relatively small.	
LOAD IMMEDIATE 10 LOOP: CALL DANNY CALL EDDY DECREMENT JUMP IF NOT ZERO LOOP	LOAD IMMEDIATE 5 LOOP: CALL DANNY CALL EDDY CALL DANNY CALL EDDY DECREMENT JUMP IF NOT ZERO LOOP

Passing fixed data	
If a block of data has to be passed to a subroutine, rather than setting up and passing a pointer to the data, put the data directly following the call and rewrite the subroutine to look for the data at the return address. This may involve more code in the data processing subroutine, but can pay off in many cases. The subroutine must compute a new return address that follows the data, and use this altered return address instead of the original.	
LOAD ADDRESS OF DATA CALL FARRAH . . . DATA: BYTES 36,24,36	CALL FARRAH DATA: BYTES 36,24,36



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Power of two	
Short tables that have more than 1 byte per entry are easier to work with if the number of bytes per entry is a power of 2. This may waste some space in the table, but may save more space and also time in the code which handles the table. Computing an offset into a table that is a power of 2 can be done with a series of shifts instead of the integer multiplication that would otherwise be required.	
TABLE: BYTES 36,24,36 BYTES 36,22,37 BYTES 38,23,38 BYTES 35,20,34	TABLE: BYTES 36,24,36,00 BYTES 36,22,37,00 BYTES 38,23,38,00 BYTES 35,20,34,00

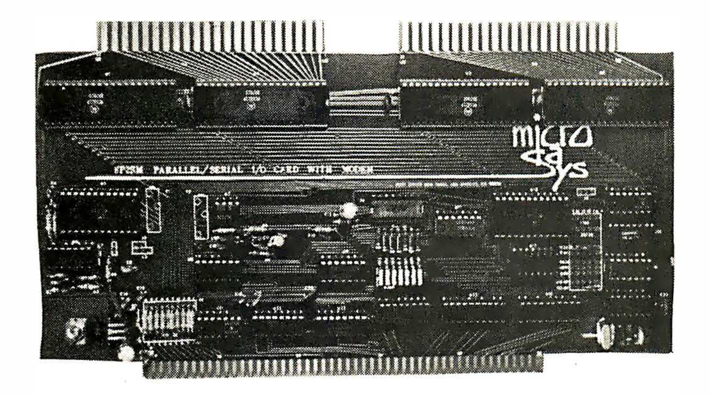
Use the stack
Instead of saving temporary values at some memory location, they can often be saved on the stack. This usually holds true, even when manipulating data on top of the stack. The details are too machine dependent to give an example, but some of the newer microprocessors recognize this by having more than one hardware-implemented stack pointer.

Combine instructions	
It is sometimes easy to miss the possibility of combining instructions. One situation which can be missed is when one can combine a symbolic value with a constant at assembly time rather than at execution time.	
LOAD IMMEDIATE ADDRESS ADD IMMEDIATE 1	LOAD IMMEDIATE ADDRESS + 1

Multiple additions	
Normally, several ADD IMMEDIATE instructions in a row would be a bad idea. In a frequent situation, however, it can be very useful. Suppose one wants to pass a number to a subroutine and have the subroutine return 1, 2, or 3, depending on whether the passed number was 5, 12, or 13 respectively. Note that the optimization shown is of space at the expense of some time.	
COMPARE IMMEDIATE WITH 5 JUMP IF EQUAL TO ONE COMPARE IMMEDIATE WITH 12 JUMP IF EQUAL TO TWO LOAD IMMEDIATE 3 RETURN ONE: LOAD IMMEDIATE 1 RETURN TWO: LOAD IMMEDIATE 2 RETURN	COMPARE IMMEDIATE WITH 5 JUMP IF EQUAL TO ONE COMPARE IMMEDIATE WITH 12 JUMP IF EQUAL TO TWO ADD IMMEDIATE -6 ONE: ADD IMMEDIATE 6 TWO: ADD IMMEDIATE -10 RETURN

[Editor's note: The techniques presented here tend to produce nonstructured programs. The programmer must make a choice between readable structured code and speed optimized code. Structured programming techniques are recommended for all programs not requiring crucial space and time specifications . . . RGAC]■

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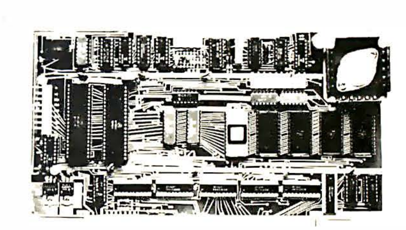
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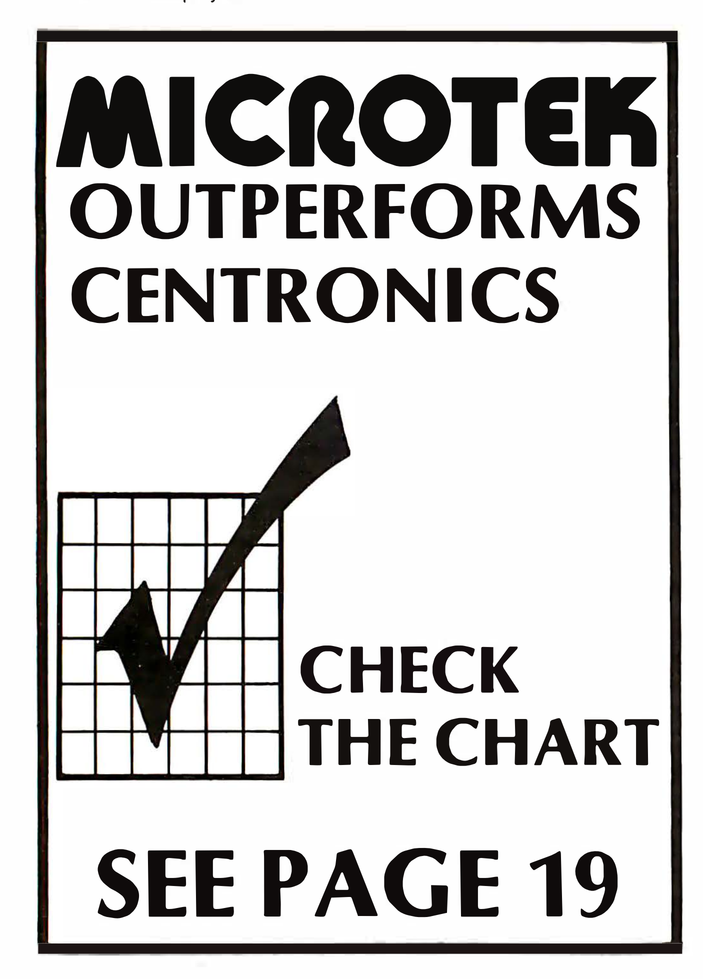
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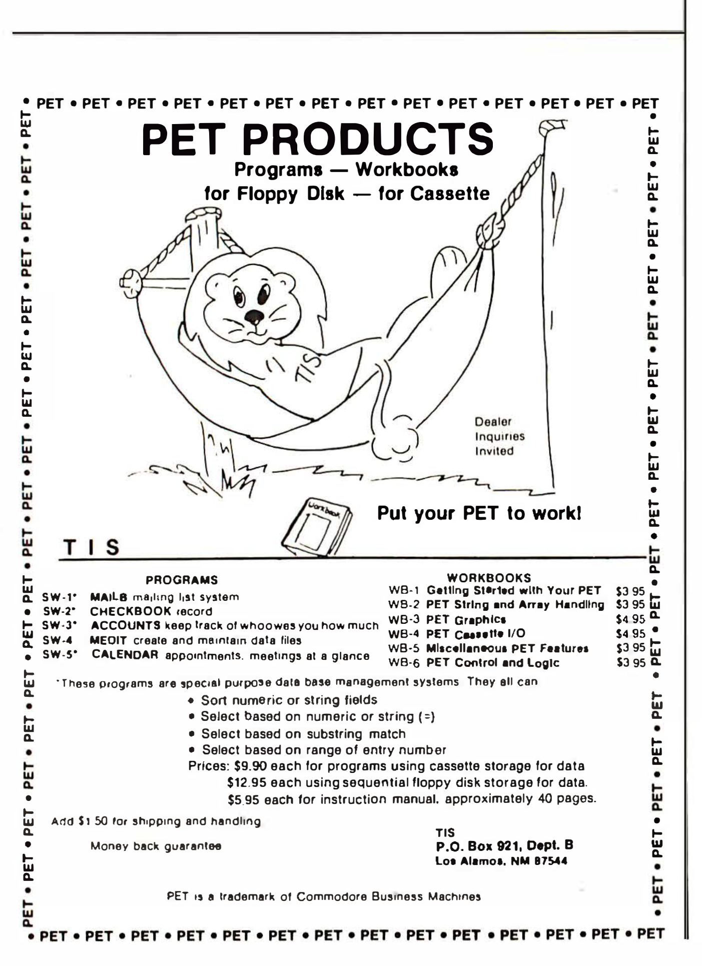
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Languages Forum

And Its Interest SNOBOLs

Dr Stefan M Silverston, 23 Deerhaven Dr,
Nashua NH 03060

I was pleased to see Mr Bruce Burns' letter in the June 1979 BYTE. As one of the small number of SNOBOL4 implementors (SNOBAT for IBM 360) around, I have always felt SNOBOL4 has much to offer the programmer, in many areas of application. It has some features provided by no other programming language known to me.

Without meaning to dampen anyone's enthusiasm, I should mention that SNOBOL4's syntax and control structures are rather lacking by today's standards. SNOBOL programs tend to be a bit hard to read, due largely to the ubiquitous blank, which can denote (1) string concatenation, (2) pattern matching, and (3) separation between labels and statement subjects. Flow-of-control also is rather opaque. The prevalence of side-effect-driven programming, for example, via value assignment in pattern matches, also detracts from program readability and maintainability. These flaws could well be remedied in any new SNOBOL implementation.

As Mr Burns points out, there are good reasons why SNOBOL4 has not been implemented on microcomputers. For one thing, SNOBOL implementations usually require considerable memory, more than what is ordinarily available on microsystems. Further, SNOBOL tends to run rather slowly in many implementations, even on large machines. This could be exaggerated for microcomputers, where storage management and swapping with peripheral memory might be necessary.

Of the 8-bit microprocessors in wide use, the Z80, with its block moves and compares, would probably be the most amenable to SNOBOL4 implementation. I intend to tackle SNOBOL4 development on my own Z80 floppy disk system in the near future, incorporating some improvements as discussed above.

SNOBOL4 should be a lot easier, as well as more efficient, with the new generation of 16-bit microprocessors. A SNOBOL implementation for the Z8000, say, should be a "natural". ■

Languages Forum is a feature which is intended as an interactive dialog about the design and implementation of languages for personal computing. Statements and opinions submitted to this forum can be on any subject relevant to its purpose of fostering discussion and communication among BYTE readers on the subject of languages. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will not be printed.

Tic-Tac-Tactics

John C Miller, 110 Riverside Dr, New York NY 10024

The May 1979 BYTE article on Tic-Tac-Toe (page 196) raises more interesting questions of programming philosophy and esthetics than those referred to in the article itself. No doubt Mr. Hinrichs' program plays an aggressive game, and never loses, as he claims. But his approach is also curiously limited in that the program is only able to play the first move side of the game, and this limitation seems the result of Mr. Hinrichs' reliance on data entries to dictate most of his move sequences. A program capable of playing the second move would be much more difficult using his methods, which are also unsatisfactory on principle because they fail to take proper advantage of the computer's most powerful capabilities.

A more rational approach, which actually involves *computing* each move rather than looking it up in a table, goes as follows:

- Win if possible; otherwise
- Block the opponent from winning on his next move if necessary; otherwise
- Set a trap (2 ways to win on your following move) if possible; otherwise
- Avoid any move allowing the opponent to set a trap on his next move, and then
- Make a (not previously avoided) move forcing (under threat of immediate loss) the opponent to make a move allowing you to set a trap, if possible; otherwise
- Avoid any move allowing opponent to force you into a move allowing him to set a trap, if possible; otherwise,
- Among moves not previously avoided, choose one which allows the opponent to blunder by choosing a move which allows you to set a trap, and then
- Among moves not previously avoided, choose one which allows the opponent to blunder by choosing a move which allows you to win on your following move, if possible; otherwise
- Choose randomly among moves not previously avoided.

As a suggestion to a reader interested in implementing this strategy, which evidently allows elegant use of subroutines, it is further suggested that the board be coded internally using the 3-by-3 magic square:

```
2 9 4
7 5 3
6 1 8
```

for which a win corresponds precisely to playing 3 numbers whose sum is 15.

The 9-step strategy outlined above has all the desirable properties of Mr. Hinrichs' program, including aggressiveness both in seeking wins and allowing opponent mistakes. In addition, it plays both first and second move equally well and "feels" right, in that it allows the computer to compute, instead of looking up moves in a data table. ■

Drop JCL and Start with WFL

Donald J Gregory, 1011 Rose Marie, #39
Stockton CA 95207

I agree with James Jones ("How to Define an OS Which Does Not Need a Wizard," April 1979 BYTE, page 245) that we must not repeat the mistakes of the past when designing operating systems for microcomputers, especially when designing the user interface. With most users writing their programs in high-level languages, it is absurd for them to be forced to write their system-interface routines in a low-level quasi-assembler designed for the convenience of the machine. What we need is an interface that is strongly based on a well-known, powerful, and easy-to-use high-level language, such as Pascal, or its progenitor, ALGOL.

Such an interface already exists — on one line of the big machines. The Burroughs Corporation Large Systems computers (series B7000/B6000) have a user interface called Work Flow Language (WFL) which is essentially a limited ALGOL with a few extensions. The basic system instructions are all handled by a few very simple commands: to run a program one simply writes RUN and the program name; to compile a program, the command is COMPILE, the program name, and the compiler's name; to copy a file, one uses the COPY command; to erase a file, simply REMOVE it; and to rename a file, just CHANGE its title. The remainder of this language consists of structures familiar to every Pascal and ALGOL user: it supports variables of type REAL, INTEGER, BOOLEAN, and STRING; for control structures there are the WHILE...DO, DO...UNTIL, IF...THEN...ELSE statements, and the ever unpopular GOTO statement. Subroutines are supported (with parameters) and values can be passed between WFL routines and the applications programs they run.

The most impressive aspect of Work Flow Language (WFL) is its handling of peripheral device assignments. Each program is permitted to have default specifications for its files in its own code, which frees the user from constantly defining his files in his WFL. But if those files in the program are not what is wanted for a particular run, the files can be redescribed in the WFL (using the ALGOL syntax for a file declaration), and the definitions in the WFL will *override* those in the program.

The use of a high-level user interface turns out to be more feasible for overall job construction. While working on an IBM-to-Burroughs conversion a year ago, I wrote a Job Control Language (JCL) to a WFL translator, and found that as many as 50 different JCL jobs could be algorithmically converted into only 1 WFL job.

There is so much power, flexibility, and convenience available in WFL that any operating system designer

must experience it before committing us all to a travesty such as JCL. The user's manual on WFL published by Burroughs Corporation does not serve as an adequate introduction to the language (it was not designed for that purpose). To help bridge this information gap, I have published a 275-page document, *the B6700 WFL Primer*, which can be obtained for $15 from Gregory Publishing Co, A C Ridlon, distributor, 6090 S Sterne Pkwy, Littleton CO 80120.

In the design of a user interface, let us not slide back into the dark ages. With WFL as an inspiration, we can begin in a user-friendly environment and go on from there. ■

Case Statements and Related Topics

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David Faught made several comments and suggestions concerning multiple conditions in the BYTE Language Forum (December 1978, page 176). The following notes are written in response to his ideas and suggestions.

First, some preliminary observations. The FORTRAN statement that corresponds most closely to the case statement is not the "numeric IF" statement; it is the "computed GOTO" statement, which has the following form:

```
GOTO (1,2,3,4,5),N
```

The numbers are statement labels, and N is an integer variable. If $1 \leq N \leq 5$, control will be transferred to the corresponding statement. If $N < 1$ or $N > 5$, the effect of the statement is undefined; most FORTRAN systems abort the program and print a diagnostic message.

FORTRAN IV, which is the most common version of FORTRAN today, has two forms of IF statement. The older form is the "numeric IF" statement. It is confusing and not particularly useful, but it was the only form of IF statement provided in FORTRAN II. The other IF statement, the "logical IF," was introduced in FORTRAN IV, but the numeric IF was retained so that FORTRAN II programs could be compiled by FORTRAN IV compilers. The FORTRAN "numeric IF" statement, in which E is an integer or real expression and the numbers are once again statement labels, is written in the following way:

```
IF (E) 1,2,3
```

Control is transferred to a labeled statement according to the value of E:

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E < 0 goes to 1, E = 0 goes to 2, E > 0 goes to 3.

The motivation for the three-way branch in numeric IF statements is efficiency. All computers have instructions which compare the contents of a register with zero, but many have no instructions for directly comparing the contents of two registers. Thus, the Boolean expression A > B is usually evaluated in machine language as A − B > 0. In FORTRAN II the programmer was forced to convert all comparisons into comparisons with zero, since the compiler would not do this for him. In practice, three-way branches are required less frequently than two-way branches in most programming applications. In FORTRAN II programs, IF statements in which the three branching labels are all different are comparatively rare; in most cases, two of the labels are the same.

When a three-way branch is really required, it can be coded in an ALGOL-like language, such as Pascal, in this way:

```
if E < 0
   then s1
else if E = 0
   then s2
else { E > 0 } s3
```

where *s1*, *s2*, and *s3* are simple or compound statements. However, this kind of code in a Pascal program is usually an indication of tricky programming, which Pascal is intended to discourage. If the expression *E* occurs naturally in the program, and happens to have negative, zero, or positive values, the above statement is appropriate.

It is more likely, however, that *E* is some kind of flag, set elsewhere in the program to −1, 0, or +1. If this is the case, it is a much better use of Pascal to define a special type for the flag, enumerate its values, and use the Pascal case statement:

```
type
   flag = (down, halfmast, flying);
var
   mapleleaf : flag;
   . . .
   case mapleleaf of
      down : s1;
      halfmast : s2;
      flying : s3
   end
```

This example leads to my principal topic: case statements. First, consider the Pascal case statement. An expression (the case selector) is evaluated, and the statement within the scope of the case keyword whose label has the same value is executed. The compiler will usually compile a case statement into a table of jump instructions in the object code, so it must be possible to map the values of the expression to the integers. In the example above, the compiler would map *down*, *halfmast*, and *flying* to the integers 0, 1, and 2, respectively. Most Pascal compilers would compile a 1000 word table for the following statement:

```
case number of
   1 : s1;
   2 : s2;
   1000 : s3
end
```

Many people have commented about the absence of an "escape" clause in the Pascal case statement. How do you tell the compiler to take special action if there is no label which matches the value of the case selector? Pascal provides a very powerful and useful notation for set operations, and tests on sets can be used to guard case statements in this way:

```
if selector in [1,2,3,7,8,9,10]
   then
      case selector of
         1,2,3, : s1;
         7,8,9,10 : s2
      end
   else error
```

This statement acts in the following manner: it decides if the value of the selector is acceptable. To be acceptable it must have one of the values in the list enclosed by square brackets, which is a Pascal set constant. If the value is acceptable, the appropriate statement (*s1* or *s2*) is selected by the case statement and executed; otherwise the procedure *error* is called. The example draws atten-

tion to a minor inconsistency in Pascal. The set expression [1,2,3,7,8,9,10] can be abbreviated to (1..3,7..10], but the case labels cannot be abbreviated in this way. It is tempting to suggest that the inconsistency be resolved by allowing case labels to be abbreviated in the same manner as set constants, but this obscures the really interesting point, which is that the case labels are, in fact, set constants themselves.

The most consistent way to write the above statement is this:

```
if selector in [1..3,7..10]
  then
    case selector of
      [1..3] : s1;
      [7..10] : s2
    end
  else error
```

This notation can be easily extended, as the next example shows. (Assume that *ch* is a letter, and that the three cases 'P', 'X',and "other" are to be distinguished; the set A−B contains all members of a set which are not also members of B):

```
case ch of
  ['P'] : s1;
  ['X'] : s2;
  ['A'..'Z'] − ['P','X'] : s3
end
```

If, however, the case statements are to be executed efficiently, the compiler must be able to evaluate the label expressions during compilation in order to generate a jump table. This implies that the case labels must not contain variables.

Enclosing the case statement in an if statement does not really solve the problem because we still have to write the acceptable case labels twice; once in the if condition, and once in the case statement itself. The only way around this is to allow an else or otherwise label, followed by a statement which is executed if there is no matching case label. Several of the more recent Pascal compilers provide this option.

As Faught pointed out in his article, the conventional if statement can also be extended in other ways. Consider the recursive definition of Ackermann's function, which can be written in Pascal in the following way:

```
if m = 0
  then a := n + 1
else if n = 0
  then a := a(m−1,1)
else a := a(m−1,A(m,n−1))
```

This could be written more elegantly using a form of the case statement in which labels are Boolean expressions:

```
case
  m = 0 : a := n + 1;
  n = 0 : a := a(m−1,1);
  (m > 0) & (n > 0):
  a := a(m−1,a(m,n−1))
end
```

Case statements of this kind must be defined carefully. Consider the general form of the statement:

```
case
  b1 : s1;
  b2 : s2;
  ...
  bn : sn
end
```

in which *b1, b2 ... bn* are Boolean expressions (sometimes called "guards") and *s1, s2 ... sn* are statements. When this case statement is executed, there are three possibilities:

- None of the Boolean expressions are true;
- Exactly one of the Boolean expressions is true;
- More than one of the Boolean expressions is true.

In the first case we can say either that the statement has no effect or, if we are designing a strict language, that it is illegal. In the second situation there is no problem. In the third situation, we can either declare the statement il-

legal, execute only one statement, or execute all the statements whose guards are true. If we select the last alternative (executing more than one statement), we must specify the precise order in which guards will be evaluated and statements executed. The necessity for this can be seen from this example:

```
case
   x < 0 : x := 0;
   x = 0 : x := 10;
   x ≥ 0 : x := x − 1
end
```

Suppose that we execute this statement with $x = 0$. Afterwards, is $x = 9$ or is $x = 10$? A language designer must consider such possibilities and specify exactly how the program will behave in each case. This is the hardest part of language design. It is quite easy to specify the *syntax* rules of a language, but is it much more difficult to specify the complete *semantics.*

The language which Dijkstra uses in his book *A Discipline of Programming* (Prentice-Hall, 1976) has a statement resembling the case statement with Boolean labels used above, although he uses different keywords and punctuation. Dijkstra uses a similar statement for loops: the entire statement is executed repeatedly until none of the guards is true.

Case statements tend to be lengthy, and it is tempting to try to abbreviate them. Faught proposes statements of (roughly) the following form:

```
case x of
   < 0 : s1;
   = 0 : s2;
   > 0 : s3
end
```

This is not general enough for all applications. For instance, it is difficult to see how Ackermann's function would be coded. There are, however, many situations in which each arm of an if or case statement makes an assignment to the same variable. In ALGOL 60, a statement has a value, and in places where other languages require a statement, ALGOL 60 allows an expression. Thus in ALGOL 60 we can write Ackermann's function in this way:

```
a :=
   if m = 0
      then n + 1
   else if n = 0
      then a(m−1,1)
   else a(m−1,a(m,n−1))
```

When ALGOL 60 was designed, many computers had only one arithmetic register, usually called the accumulator. A high level language compiler compiling one statement at a time would not usually, in the current statement, use the value left in the accumulator by the previous statement. The ALGOL convention was intended to get around this potential inefficiency by allowing a statement to have a value, the value being that left in the accumulator after the statement was executed.

This idea was carried over to ALGOL 68, which also has a case statement. It is less flexible than the case statements described above because there are no case labels. Instead, the introductory clause "case m in" is followed by n statements, and if $1 \leq m \leq n$, the mth statement is executed.

Thus, the ALGOL 68 case statement is very similar to the FORTRAN computed GOTO statement. Although the lack of case labels makes the ALGOL 68 case statement rather weak and sometimes hard to read, it does enable the compact expression of some algorithms. As in ALGOL 60, an expression may be used where a statement is expected. The algorithm for determining the number of days in a month can be expressed in ALGOL 68 in the following way:

```
days :=
   case month in
      31,
      if year mod 4 = 0
         then 29
         else 28
      fi,
      31,30,31,30,31,31,30,31,30,31
   esac
```

Most languages since the mid sixties have a case statement of one kind or another. For a fuller description of the use of case statements in various languages, read the paper "Notes on the case Statement" by C Wrandle Barth, in *Software: Practice and Experience*, volume 4, #3, 1974, pages 289 thru 298. ■

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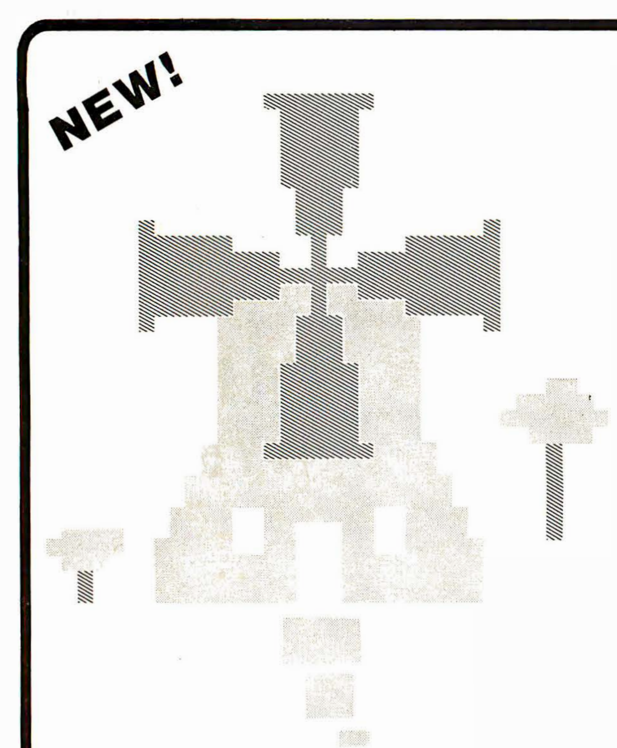
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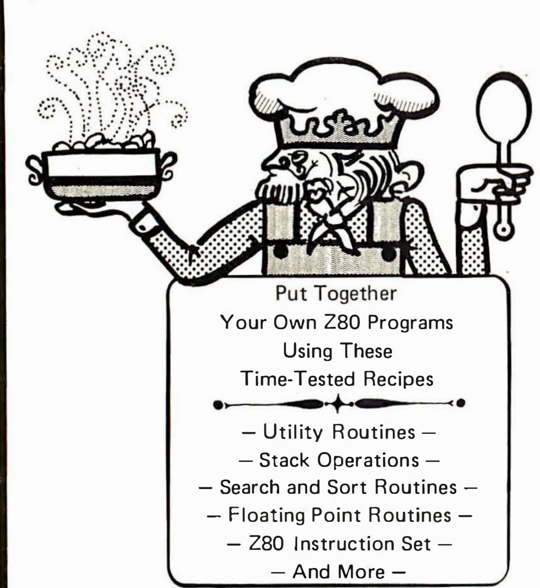
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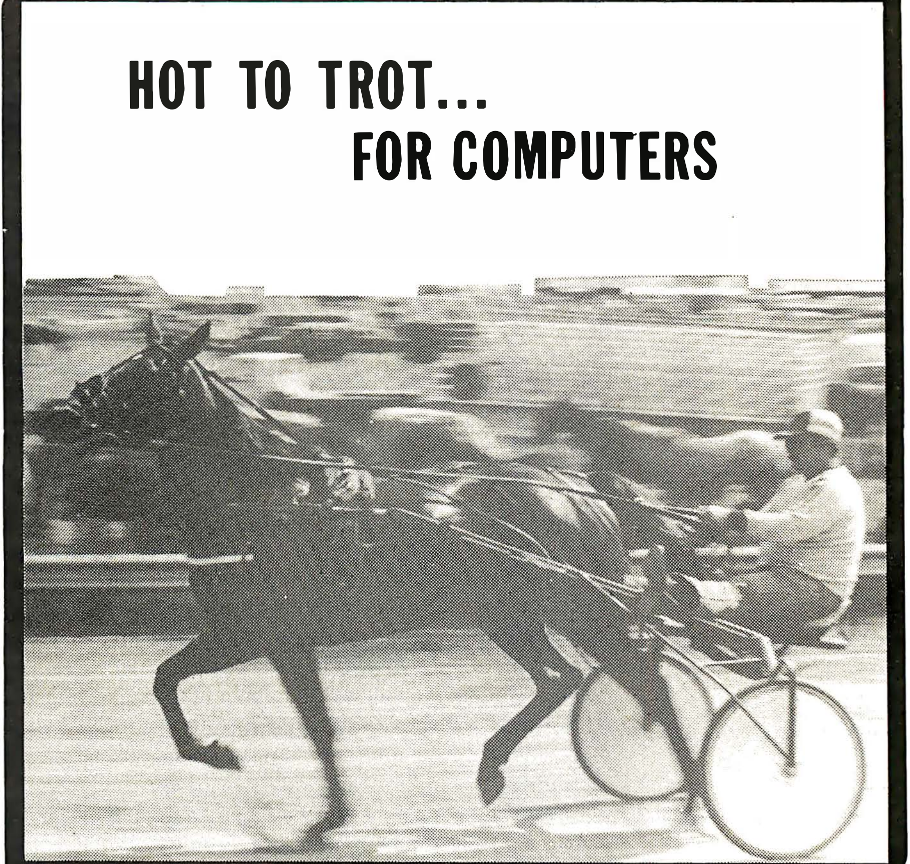
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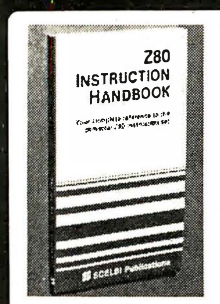
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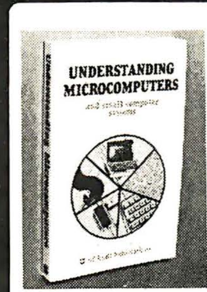
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Some Laws of Personal Computing

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The Origins of Personal Computing

In the beginning, man created pocket calculators to do rote arithmetic, eg: addition, subtraction, multiplication and division. Few people involved in the pocket calculator industry realized that pocket calculation was just the initial thrust into the "computing for the millions" consumer market. Indeed, the millions of dollars made by this computer consumer product helped to pay for the development of more sophisticated devices we now call personal computers.

Computing lacks a definite starting point. The works of Charles Babbage, and possibly Alan Turing, have little impact on daily computing (some will argue that these two pioneers have everything to do with modern computing, but I speak of practical rather than theoretical computing). So where are the fundamental theorems of computing? Is there a set of "equations of motion" for programming?

This article contains ten empirical observations, dubbed "laws of personal computing," that are derived from personal experience with personal computers in the real world of business. While many of the rules are controversial, I believe most can be proven to be true.

The first law of personal computing is of the form "action equals reaction." The law is derived by historical observation.

The first electronic computers were personal computers. That is, only a few programmers had access to the ENIAC, Whirlwind, and ATLAS. This arrangement faded rapidly in favor of batch operation and multiprogrammed operating systems. Clearly, the shift was the result of economic decisions. Large corporations poured large sums of money into data processing departments, and demanded efficiency in return. Military installations required security and performance as their return on investment. Batch operation satisfied their demands.

However, users (programmers mostly) were soon able to show economics of scale and efficiency of operation by installing a limited form of interaction called *remote job entry.* Remote job entry moved rapidly into timesharing with terminals because this increases the man-machine interaction. Finally, we have come full circle to dispersed, stand alone, turnkey computers dedicated to a few users.

The key feature of the historical evolution of computing is "interactiveness." The more we can communicate with a computer system, the more we can enjoy using the system (within limits), and the more "personal" computing becomes. This leads to the first law of personal computing:

1. Personal computing equals interactive computing: the personalness of a computer system increases in direct proportion to its interactiveness.

The New Economics of Computing

Personal computing is governed by economics as much as by technology. Indeed, the directions taken by technology are governed by economics. Therefore, we must study economics in order to derive other laws of computing.

The concepts of programming, microprogramming, and integrated circuit design span the spectrum of software, firmware and hardware. Why is it more suitable to microprogram the IBM 370/168 (model 370 hardware, model 168 firmware) and not microprogram the Intel 8080? Where is the tradeoff between an "expensive" system and an "inexpensive" system when all features of such a system are considered?

A system designer can choose to build a cheap processor (like the 8080, say) and save money on production, design, and maintenance of the cheap processor. The same designer can elect to build an expensive, sophisticated computer system and as a result increase the cost of hardware. Why construct an expensive computer? The

answer lies in looking at the total cost of a computer system. Let's take an example: the Intel 8080 requires that the HL registers be loaded each time a memory reference is made. This feature is simple to implement and saves hardware dollars. However, every program written for the 8080 must pay the price of this simplicity. Typically, a macro called HL is used to relieve the programmer of this chore. The Motorola 6800 includes a more sophisticated addressing mechanism using an index register for assisting in memory references. The addressability features of the 6800 often lead to 25 percent reduction in the number of instructions needed to perform the same function on the 8080. Both 6800 and 8080 architectures are more time consuming to program than the Texas Instruments 9900 chip due to the 9900's greater sophistication. Furthermore, the Microdata 32/S and Hewlett-Packard 3000 are stack machines supporting a high level language. Hence they are "easier" to program than any of the chips discussed above. But of course, the 32/S and 3000 are more expensive hardware machines than the chip machines.

Where is there a trade-off between complexity in hardware, complexity in firmware, and complexity in software? The trade-off is strictly economic, and leads to the second law of personal computing.

2. Conservation of agony: the work expended to program a computer to solve a problem plus the work expended to construct the computer system remains constant for that problem.

The second law of personal computing actually states that the problem solution remains at a constant level of complexity regardless of the system used to solve the problem.

The cost per unit of effort in building hardware may decrease (large scale integrated circuit (LSI) devices), and the cost of programming may increase (due to unsophisticated microcomputers). Therefore, in 1980, the most economical systems will be mainly firm hardware (due to its low cost) and a small share in software (due to the conservation of agony).

The results of the second law say something about the "power" of a computer system. Increasing speed or storage capacity increases power. Conversely, decreasing cost increases power of a personal computer. For example, the Intel 4040 (4 bit pocket calculator chip) increased personal computing power because it was cheap even though it was slow and had little storage capacity.

If we look at history once again, it is clear that an acceleration force is at work: increasing capability leads to an increasing number of applications in which the computer can be useful. In turn, the increased use of computer systems in new applications results in increased sales. The sales stimulate mass production and further cost reductions. The result is to decrease the unit cost of the computer system.

We can demonstrate this counter intuitive notion as follows. In the mid-1960s, processor speed increased dramatically. This encouraged timesharing of the central proc-

essor. The support of many terminals reduced both the cost per terminal and the cost of the unit of computation.

In the 1970s, the storage capacity has been increasing dramatically. There is a surge of activity in data base applications and a corresponding decrease in cost of storage. In short, we are witnessing the third law of personal computing in action:

3. As the power of a personal computer increases, its price decreases.

The third law deals only with hardware capability. Earlier we stated that hardware capability plays a decreasingly important role in personal computing. Indeed, the effects of the third law of personal computing are rapidly diminishing due to the fourth law:

4. Software is hard; hardware is soft: it is economically more feasible to build a computer than to program it.

It is economically easier to design, implement, and mass produce a machine like the Intel 8080 or IBM 360 than it is to design and implement an operating system, compiler, or sophisticated application program. The cost of a chip may run to $250,000 when design and initial production are totaled. The cost of firmware BASIC may not exceed $100,000 (many do, however), but the auxiliary costs of documents, service, training and marketing may exceed one million dollars.

A company contemplating a new hardware architecture is gravely penalized for making radical changes to the instruction set of their existing computer. Is it not to be expected that the IBM 370 is only an evolutionary departure from the IBM 360? Why is the Z80 processor nearly as successful in the market place as the 8080?

The high cost of programming as opposed to the cost of a chip is reversing the traditional roles of software and hardware. In the future, more emphasis will be placed on the software and less emphasis will be placed on the machine architecture. Indeed, much of the current software will become "hard," by being distributed in hardware read only memories as firmware.

One result of the fourth law is corollary A, which states the rule that governs pocket calculators today:

A. Programs and data should be shared, but hardware should be replicated.

The only item in a computer system that must be shared from a technological standpoint is data. Common access to information stored in a data base may be logically justified by an application. Whether the access is done by timesharing or by dispersed processors is immaterial. Also, whether the data is copied for transmission, or the program that intends to process the data is copied for transmission to the data base machine is again immaterial.

The computer business has been overly enthusiastic about timesharing in the past. We must recall that timesharing was invented to lower the cost of hardware. Now that hardware is no longer the major cost item in a system, timesharing is not justifiable in most cases. In fact, I believe that timesharing failed. It failed because people couldn't understand it. Only computer experts are able to use MULTICS, VM/370 and other extremely capable timesharing systems. The average person will not tolerate JCL, telephone lines, computer jargon, and unreliable central computers that lose their files. In short, timeshared computers are hampered by their prerequisite of knowledge.

The computer utility concept of the late 1960s failed because of the lack of expertise on the part of the users. The high level of sophistication needed to use a utility doomed it to failure. It also put a bad name on personal computers.

In effect, the "guilt by association" syndrome plagues personal computing today. Myths (it's too complicated), training (what is a byte?), and service (how do I get statements printed?) are three of the remnants of the computer utility that have turned people away from computing.

We can now state a conclusion called the fifth law of personal computing:

5. Knowledge costs more than software and hardware: the usefulness of personal computers increases in inverse proportion to how much people must know in order to use them.

The lesson is clear: any consumer product that is successful must be simple. The pocket calculators that solve known problems (arithmetic) are successful. The pocket calculators that solve unknown or unrecognized problems are failures.

The facts of life are even more severe for computers sold to the consumer market. The final economic law succinctly summarizes the fickle buyer's attitude:

6. The color, shape and size of a personal computer are often more important to a buyer than what is inside of it.

Once the personal computer system overcomes all other economic obstacles, it must be packaged and maintained by a reputable service organization. This means that all unnecessary buttons, switches and knobs must be eliminated. The manuals must reduce jargon and the software must be tailored to a particular industry.

The WH89 system by Heath, the C4P by OSI, the Apple II, the Commodore PET and the Radio Shack TRS-80 are all vivid examples of packaging in the personal computer hobby market. Datapoint, Wangco, and Basic-Four demonstrate the law with tailored software packages for small businesses.

Service fills the gap between the user's knowledge and the personal computer's lack of capability. Service rescues the user when the personal computer cannot repair itself. It is service that counts when the manuals do a poor job of explaining a feature of the system. Finally, service is performed by humans, and so far, humans understand other humans better than they understand a machine.

We can now turn to some interesting examples that lead to the final laws of personal computing. In particular, these laws affect the majority of computer experts engaged in applications implementation.

Implications of Interactiveness

The first law of personal computing equates "interactiveness" with "personalness." That is, in order to achieve a high degree of interactive computing, the personal computers of the future must be oriented toward languages and systems with a high degree of interpretation. Compiler languages, for example, have been shown to

require from three to ten times as much effort in implementing a given program as an interpreter would require.

It is little wonder that BASIC has achieved the title "language of the masses." It is a simple interpretive language, easy to implement on a modest processor. Unfortunately, it is extremely inappropriate for major applications requiring typical business data processing.

7. BASIC is to personal computing as sign language is to English.

BASIC programs are easy to write, but difficult to understand, and provide inadequate control of a personal computer system. Few dialects of BASIC permit indentation, structuring, comments (without memory penalty), or error control and recovery. Here are a few objections to BASIC as a serious, professional implementation language.

a. Poor error recovery facilities, eg: the application program must be capable of detecting file access errors, etc, and then calling an exception handling routine.
b. No dynamic overlapping or memory mapping of programs too large to fit in main memory.
c. Restricted data structures, eg: no provisions for linked lists, trees, dynamic memory allocation for data, mixed data types.
d. Limited user prompting, eg: forms handling, cursor control, scrolling and audio signals are lacking.
e. Inadequate software security and protection, eg: no file security locks, interlock mechanisms for shared files, or source code shielding.
f. Slow execution due to poor interpretation.
g. Inadequate primitives for standard data processing, eg: no sorting, file access constructs, forms handling for report generation, or communications access constructs.

In short, BASIC is useful in the development of small programs for unsophisticated applications, or for programs that will be thrown away rather than modified.

The area of system control is no better off than the system languages area of personal computing. At least BASIC is partially standardized and widely known. Operating systems, on the other hand, have no consistent basis to begin with. Indeed, we question the utility of an operating system in interactive computing. This is pointed out in the eighth law:

8. An operating system is a feeble attempt to include what was overlooked in the design of a programming language.

This heretical notion is fully obvious in systems employing interpretive BASIC to the hilt. The Wangco, Tektronix 4051, and similar small scale interpretive BASIC systems have no visible operating system. All commands normally associated in traditional operating systems are put into extended BASIC in these personal computers. In general, interpretive systems (and thus interactive systems) have no need for an operating system.

In future personal computers, it is likely that a network of loosely coupled processors will communicate data and programs to one another. In such a network concurrent processes will be allowed and will often compete for limited resources. In this situation the synchronizing primitives of today's operating systems will migrate to hardware (or firmware) and not be of concern to the language interpreter.

The Ultimate Laws

We have covered the motivations for personal computing and have stated eight laws along the way. In the final analysis we can derive two ultimate laws of computing used (knowingly or otherwise) by computer

manufacturers:

9. The ultimate personal computer is a robot: the goal of personal computing is to reduce the differences between humans and computers.

In effect we are striving to make personal computers do what people can do, but faster, more accurately, and cheaper. We seek a partnership with personal computers akin to the symbiosis between humans and household pets.

A faster personal computer allows us to process census information in two or three years instead of 15 years. Speed is essential in a lunar landing, and so is accuracy. An air traffic control computer is much more accurate than a human operator. The result is safer air transportation for people.

10. Knowledge is power: information is the fabric of knowledge; the controller of information wields power.

While personal computers are fast, accurate and cheap, they also cause high speed propagation of errors, speed of light crime, and sometimes loss of life when they fail.

Politicians are able to push a button and disseminate campaign propaganda to the millions. Factories can replace entire vocations by automating production. Financial institutions are at the mercy of their data processing centers.

The laws of personal computing are not only important to computer scientists, but also to society as a whole. Perhaps there is a place today for the futurist, the philosopher of computer science.■

Circle 153 on inquiry card.

BYTE's Bits

Trees

Guy L Steele Jr, MIT Artificial Intelligence Lab,
Massachusetts Institute of Technology, Cambridge MA 02139

I think that I shall never see
A matrix lovely as a tree.
Trees are fifty times as fun
As structures a la PL/I
(Which Dijkstra claims are too baroque).
And SNOBOL's strings just can't compare
With all the leaves a tree may bear,
And COMIT strings are just a joke.
Vectors, tuples too, are nice,
But haven't the impressive flair
Of trees to which a LISP is heir.
A LISPer's life is paradise!

Many people think that JOSS
And others, too, are strictly boss;
And there are many BASIC fans
Who think their favorite language spans
All that would a user please.
Compared to LISP they're all a loss,
For none of them gives all the ease
With which a LISP builds moby trees.

RPG is just a nurd
(As you no doubt have often heard);
The record layouts are absurd,
And numbers packed in decimal form
Will never fit a base-two word
Without a veritable storm
Of gross conversions fro and to
With them arithmetic to do.
And one must allocate the field
Correct arithmetic to yield
And decimal places represent
Truncation loss to circumvent:
Thus RPG is second-rate.
In LISP one needn't allocate
(That boon alone is heaven-sent!)
The scheme is sheer simplicity:
A number's just another tree.
When numbers threaten overflow
LISP makes the number tree to grow,
Extending its significance
With classic tree-like elegance.
A LISP can generate reports,
Create a file, do chains and sorts;
But one thing you will never see
Is moby trees in RPG.

One thing the average language lacks
Is programmed use of push-down stacks.
But LISP provides this feature free:
A stack — you guessed it — is a tree.
An empty stack is simply NIL.
In order, then, the stack to fill
A CONS will push things on the top;

To empty it, a CDR will
Behave exactly like a pop.
A simple CAR will get you back
The last thing you pushed on the stack;
An empty stack's detectable
By testing with the function NULL.
Thus even should a LISPer lose
With PROGs and GOs, RETURNs and DOs,
He need his mind not overtax
To implement recursive hacks:
He'll utilize this clever ruse
Of using trees as moby stacks.
Some claim this method is too slow
Because it uses CONS so much
And thus requires the GC touch;
It has one big advantage, though:
You needn't fear for overflow.
Since LISP allows its trees to grow,
Stacks can to any limits go.

COBOL input is a shame:
The implementors play a game
That no two versions are the same.
And rocky is the FORTRAN road
One's alpha input to decode:
The FORMAT statement is to blame,
But on the user falls the load.
And FOCAL input's just a farce;
But all LISP input comes pre-parsed!
(The input reader gets its fame
By getting storage for each node
From lists of free words scattered sparse.
Its parses all the input strings
With aid of mystic mutterings;
From dots and strange parentheses,
From zeros, sevens, A's and Z's,
Constructs, with magic reckonings,
The pointers needed for its trees.
It builds the trees with complex code
With rubout processing bestowed;
When typing errors do forebode
The rubout makes recovery tame,
And losers then will oft exclaim
Their sanity to LISP is owed —
To help these losers is LISP's aim.)

The flow-control of APL
And OS data sets as well
Are best described as tortured hell.
For LISPers everything's a breeze;
They neatly output all their trees
With format-free parentheses
And see their program logic best
By how their lovely parens nest.
While others are by GOs possessed,
And WHILE-DO, CASE, and all the rest,
The LISPing hackers will prefer
With COND their programs to invest
And let their functions all recur
When searching trees in maddened quest.

Expanding records of fixed size
Will quickly programs paralyze.
Though ISAM claims to be so wise
In allocating overflow,
Its data handling is too slow
And finding it takes many tries.
But any fool can plainly see
Inherent flexibility
In data structured as a tree.

When all their efforts have gone sour
To swell fixed records, losers glower.
But list reclaimers hour by hour
By setting all the garbage free
Yield CONSequent capacity:
Thus trees indefinitely flower.
(And trees run on atomic power!)

To men of sensibility
The lesson here is plain to see:
Arrays are used by clods like me,
But only LISP can make a tree.

- The Great Quux (with apologies to Joyce Kilmer)

How this poem came to be printed
Notes by C Helmers

The above parody was found on the MIT Artificial Intelligence Laboratory's computer during a recent (July 3) visit made to Henry Baker at the University of Rochester Computer Science Department. Its content reflects the LISP orientation of our August 1979 issue, and in a humorous way summarizes the true artificial intelligence hacker's point of view about LISP as a tool.

Henry dug up an electronic view of the poem on the computer and communicated by that means my desire to make it more widely available. The poem's author, it turns out, is Guy Steele, who is presently connected with the MIT Artificial Intelligence Laboratory. I had in fact spent some time talking with Guy on a previous occasion, not knowing anything at all about his penchant for poetic parody. The poem was written in 1973.

One of Guy's major technical accomplishments to date is his recent student project at MIT: design and implementation of a LISP-machine chip in silicon.

In his letter accompanying the poem, Guy points out that probably the most obscure piece of jargon is the word "moby" used as an adjective. The etymology is a reference to Melville's whale, Moby-Dick. Thus a "moby tree" is a tree which is figuratively as large as a whale, or gigantic. Most of the other terminology referring to LISP is covered in recent BYTE issues; the references to other languages such as JOSS, RPG, FORTRAN, FOCAL, APL, the OS operating system of IBM, etc are best left undefined for the purposes of the poem.

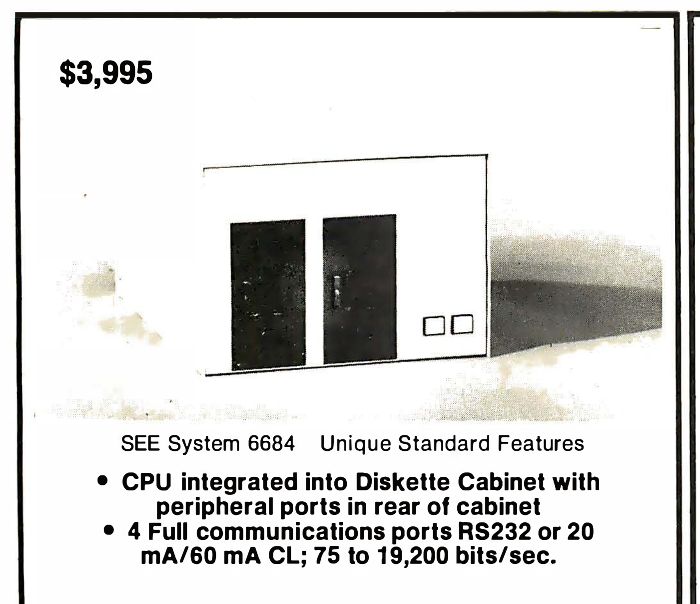
The import of the communications network as a tool for individual computer users is signified by the practical example provided in this poem's arrangement for use in BYTE. The file containing "Trees" was publicly available to any person signing onto the MIT-AI computer. Henry Baker in particular was able to sign onto the computer from his usual location in Rochester, NY via the Arpanet, an electronic network connecting many research computers. Henry then left a "mail" message via the network for Guy at Stanford, California, where Guy was spending the summer. Guy then got in touch with me at my office by phone (also electronic). The arrangement was concluded with transmission of a physical copy to BYTE via the postal service.

Readers of BYTE who own personal computers with an RS-232 interface will soon be able to sign up for private services equivalent to the electronic mail functions used by Henry and Guy in arranging this over the Arpanet. At least 2 different companies now offer (see recent advertisements) private off-hours timesharing and networking services at relatively low rates. These are typically billed via Master Charge and VISA. One of these services, Telecommunications Corporation of America, *promises to offer a nationwide users' directory of identification numbers for its users, analogous to a phone directory. This arrival of individual-oriented digital communications-oriented networks will probably mark one of the great milestones of personal computing.* ■

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Space Game

Loring C White
26 Boswell Rd
Reading MA 01867

Listing 1: Altair BASIC listing for Space Game. This program allows data entry without the use of a return. This increases the real-time appearance of the game.

```
10 PRINTCHR$(26)
20 Y5=5:GOSUB670
30 PRINT"YOU HAVE BEEN ASKED TO GO ON A MISSION TO DESTROY FIVE"
40 PRINT"ENEMY CRAFT THAT THREATEN THE GALAXY-----"
50 PRINT"YOU MUST POSITION YOUR CRAFT SO THAT THE ENEMY "
60 PRINT"IS IN POSITION IN THE CENTER OF YOUR GUN SIGHT IN ORDER"
70 PRINT"TO DESTROY THE ENEMY SPACECRAFT.
80 PRINT"THE AIMING IS DONE AS FOLLOWS:"
90 PRINT"HIT A 'U' FOR UP MOTION"
100 PRINT"HIT A 'D' FOR DOWN.MOTION"
110 PRINT"HIT A 'L' FOR LEFT MOTION"
120 PRINT"HIT A 'R' FOR RIGHT MOTION"
130 PRINT"HIT A 'F' TO FIRE ROCKETS"
140 PRINT"HIT A 'CONTROL C' TO ABORT THE MISSION (CHICKEN OUT!)"
150 PRINT"THE ENEMY RETURN FIRE WILL GRADUALLY DESTROY YOUR AIMING
160 PRINT"ABILITY!!!!!! SO DON'T DELAY!!!!"
170 FORN=0TO15000:NEXT
180 INPUT"TYPE 'N' FOR NOVICE PILOT;'E' EXPERIENCED;'A' FOR 'ACE'";V$
190 IFV$="E"THENV8=150
200 IFV$="N"THENV8=300
210 IFV$="A"THENV8=75
220 PRINTCHR$(26)
230 Y5=10:X5=10:GOSUB670
240 PRINT"-----GOOD LUCK ON YOUR MISSION --- ON INTO BATTLE!!!"
250 FORN=0TO1000:NEXT
260 POKE3758,18:POKE4031,18
270 D2=1:D1=1:PRINTCHR$(26)
280 GOSUB1140
290 Y5=6:X5=0:GOSUB670:GOSUB500
300 Y5=INT(10*RND(1)+7)
310 X5=INT(20*RND(1)+21)
320 GOSUB670
330 GOSUB640
340 GOSUB690
350 GOSUB1080
360 IF(INP(16)AND1)=0THEN350
370 D=(INP(17)AND127)
380 GOSUB670
390 IFD=76THENX5=X5+1
400 IFD=82THENX5=X5-1
410 IFD=85THENY5=Y5+1
420 IFD=68THENY5=Y5-1
430 IFD=70THEN710
440 IFD=3THEN490
450 GOSUB1050
460 GOSUB670
470 GOSUB640
480 GOTO340
490 POKE3758,16:POKE4031,16:END
```

Listing 1 continued on page 198

If you don't have analog graphics capability but do have an 8080 computer with a video display such as the ADM-3A, you may find this program a real challenge.

For the past year or so I have been using the ADM-3A video monitor for running programs written for Teletype display, such as the early *Star Trek* games. Most of the new games are written with cursor control, giving a vast improvement to the display. When I utilized the cursor control feature of the ADM-3A it opened up a new world of programming enjoyment; with cursor control it is possible to write various areas on the screen without disturbing others.

For example, in business programming it is desirable to preserve various tables and enter data at the end of each line without having to rewrite the table every time new data is written. In card games such as blackjack, it is convenient to print out the various cards in a line from left to right and hold the display while other cards are being written on another part of the screen. This type of display is possible only with a terminal having cursor control. Most of the programs I have rewritten are much more pleasing in the cursor control format.

The program in listing 1 features capabilities not found in many of the space war games available commercially. It does not require a graphics or analog display terminal. In order to realize the full capabilities of the game it is necessary to have a 24 line by 80 character video monitor set for 9600 bps or faster, with a BASIC speaking computer. My system runs in MITS Altair, 16 K Extended BASIC, and the program itself will run in less than 4 K bytes of memory. MITS Altair 8 K Revision 3.2 BASIC can also be used and the program revisions are discussed below.

Program Features

Some of the features of the program are:

- The enemy craft takes evasive action during the run.
- There are three levels of difficulty: novice pilot, experienced pilot and ace.
- Final performance classification is displayed after each mission.
- Based on the skill of the pilot, the computer adjusts the degree of difficulty accordingly. Thus a novice can advance to experienced or ace by achieving a 75 percent record or better over a set time. Likewise a poor performance results in a down-



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Circle 56 on inquiry card.

Listing 1 continued from page 196:

```
500 PRINT"                    --------------------"
510 PRINT"                             I"
520 PRINT"                             I"
530 PRINT"                             I"
540 PRINT"          I                                      I"
550 PRINT"          I          I              I            I"
560 PRINT"          I----------I              I------------I"
570 PRINT"          I          I              I            I"
580 PRINT"          I                                      I"
590 PRINT"          I                  I                   I"
600 PRINT"                             I"
610 PRINT"                             I"
620 PRINT"                    --------------------"
630 RETURN
640 PRINT"I-O-I";
650 P=Y5:Q=X5
660 RETURN
670 PRINT CHR$(27)+"="+CHR$(32+Y5)+CHR$(32+X5);
680 RETURN
690 PRINTCHR$(27)+"="+CHR$(32)+CHR$(32);
700 RETURN
710 IFY5=12THEN740
720 GOSUB880
730 GOTO320
740 IFX5=31THEN770
750 GOSUB880
760 GOTO320
770 Y5=12:X5=30:GOSUB670:PRINT" POW     "
780 FORN=0TO100:PRINTCHR$(7);:NEXT
790 FORN=0TO100:NEXT
800 GOSUB670:PRINT"      "
810 FORN=0TO100:NEXT
820 Y5=22:X5=0:GOSUB670
830 PRINT"M A Y   T H E   F O R C E   B E   W I T H   Y O U   !!!!!"
840 Y5=1:X5=50:GOSUB670
850 PRINT"ENEMY DESTROYED=";DI
860 DI=DI+1:IFDI=6THEN920
870 GOTO300
880 P=Y5:Q=X5:Y5=2:X5=50:GOSUB670
890 PRINT"NUMBER MISSED=";D2:D2=D2+1
900 Y5=P:X5=Q:GOSUB670
910 RETURN
920 Y5=22:X5=10:GOSUB670
930 D2=D2-1
940 Y5=20:X5=0:GOSUB670
950 PRINT"THE HOME BASE HAS BEEN SAVED-CONGRATULATIONS!!"
960 PRINT"YOUR MISSION RECORD:  ";5/(5+D2)*100;"% PERFORMANCE"
970 IF5/(5+D2)*100>75THENV8=V8-50
980 IF5/(5+D2)*100<51THENV8=V8+50
990 PRINT"DO YOU WANT ANOTHER MISSION                    "
1000 IF(INP(16)ANDI)=0THEN1000
1010 X=(INP(17)AND127)
1020 IFX<>89THENSTOP
1030 GOTO270
1040 Y5=0:X5=0:GOSUB670
1050 PRINTCHR$(27)+"="+CHR$(32+P)+CHR$(32+Q);
1060 PRINT"      "
1070 RETURN
1080 T=T+1
1090 IFT>V8THEN1110
1100 RETURN
1110 IFX5>36THEN1116
1111 IFY5<12THEN1116
1112 X5=X5-1:Y5=Y5+1:GOSUB1050:GOSUB670:GOSUB640:GOSUB690:GOTO1120
1114 GOTO1120
1116 X5=X5+1:Y5=Y5-1:GOSUB1050:GOSUB670:GOSUB640:GOSUB690:GOTO1120
1120 IFY5>18THENPRINTCHR$(26):PRINT"YOU'RE SHOT DOWN!!":GOTO490
1122 IFY5<5THENPRINTCHR$(26):PRINT"YOU'RE SHOT DOWN!!":GOTO490
1130 T=0:RETURN
1140 IFV8<=75 THENQ$="RATING=ACE PILOT"GOTO1170
1150 IFV8>=300THENQ$="RATING=NOVICE PILOT":GOTO1170
1160 Q$="RATING=EXPERIENCED PILOT"
1170 Y5=2:X5=25:GOSUB670
1180 PRINTQ$
1190 RETURN
```

grade in classification and a resulting slower evasive action taken by the enemy. Performance record is based on the number of enemy craft destroyed to the number of misses.

- During the mission the enemy craft gradually destroys the pilot's capability to aim rockets, and thus time becomes an important factor.

Program Description

At the start of the program the instructions are listed and you are asked to classify yourself in accordance with your capabilities. At this point it is best to start off with the novice classification by typing an N. If you show promise you will be upgraded as each mission is accomplished, and can advance to ace with some practice and concentration. It should be mentioned however, that no matter how good you think you are, the computer can and will speed up enemy evasive action and it will become more and more difficult to complete the mission with good results. If the enemy craft is allowed to maneuver too far off the display you will be shot down and the game will be over.

One of the features of the game is pilot data entry without use of the return key. This was programmed by using the INP function of Altair BASIC. It is possible to maneuver the plane by just hitting one key, such as the U key, for upward motion. In order to get reliable performance of the computer with the INP function it is necessary to disable the control C function of Altair BASIC. The control C is normally used for aborting program execution and returning to command mode. The control C function is temporarily disabled in Altair 16 K BASIC Revision 4.0 by poking decimal addresses 3758 and 4031 to an unused port (port 18 on my system). The program is set up for the MITS, 2SIO board with the video monitor located at port number 16. If you have your monitor at another port, it is necessary to change lines 260, 360, 370, 490, 1000 and 1010. For example, if you have a video monitor at port 0 then change:

Line 360 to IF(INP(0)AND1)=0 THEN350
Line 370 to D=(INP(1)AND127).

These changes assume that your status and data ports are 0 and 1 respectively. Also change lines 1000 and 1010 in the same way. For those of you who wish to run the program with Altair, 8 K BASIC, Revision 3.2 you may change the control C disable routine as follows:

Line 260 POKE1422,18:POKE1514,18
Line 490 POKE1422,16:POKE1514,16

where 18 is an unused port and 16 is the video status port. Line 490 restores the Altair BASIC control C feature, and line number 260 aborts the control C, permitting pilot control direct from the keyboard without use of the carriage return key. If you enjoy programming, try this on your *Star Trek* program to eliminate the need to use the return key.

Running the Game

After typing RUN, the instructions are clearly listed and time is allowed for the average reader to absorb the mechanics of the game. You are then asked what level of competence you have as a pilot. After you type in the appropriate response and hit a carriage return, the board is displayed and the enemy craft is randomly positioned in range of the gun sight. You are allowed a reasonable time to maneuver your craft (not the enemy) to where the enemy plane is in a more central position within the gun sight, but if you delay too long or fumble, the enemy will take evasive action and it will be necessary to reposition your gun sight.

Once the plane is positioned in the exact center of the gun sight you must fire the rocket by hitting the F key. If this can be done before the plane moves out of line you will have done the job and the appropriate score will be entered in the upper righthand corner of the screen. If you fire before the plane is centrally located, a miss is recorded.

Your score and rating are adjusted appropriately after each mission (five craft must be shot down). By achieving a 75 percent or better record you can increase your rating by 50 points and eventually advance to the next higher rating. The next rating also changes the degree of evasive action taken by the enemy and hence grows with the pilot's competence. In like manner, if you fail to complete your mission, your rating will be lowered and the game will become easier, in keeping with your ability as a pilot. You will be demoted only if the number of misses exceeds the number of craft shot down.

Using Other Video Monitors

For those readers who have other types of (cursor controlled) video monitors it will be necessary to change lines 670 and 690. Line 690 homes the cursor to the upper left corner of the display and whatever procedure is appropriate to do this on your monitor may be substituted for this subroutine. Line 670 positions the cursor at the X,Y location desired for the particular printout desired. The Y position is the variable Y5 and the X position is X5.

For example, if you want to position the printout at the exact center of the screen (24 lines by 80 characters) then Y5 is set to 12 and X5 is set to 40. Cursor control programming involves only the additional information of where to print just before the PRINT statement is issued. By using a subroutine to locate the cursor for each print statement, you avoid having to rewrite the location for every printout. In this particular program we call a subroutine at line 670 after specifying Y5 and X5. In some cases the cursor should remember where it was on a previous printout, and in that case I set the variables P and Q to the original Y and X locations for storage (see line 650).

If you haven't tried a terminal having cursor control you are missing a lot. Try this game and you may be tempted to convert some of your old business or game programs using the above techniques.■

Easy to Use Hashing Function

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Portland OR 97229

Hashing, or scatter storage, is a well known and widely used technique for handling lists. Perhaps the most common usage is in assemblers and compilers where it greatly speeds the handling of symbols. This article briefly discusses the merits and drawbacks of hashing relative to other sorting and searching techniques and presents an easy to use hashing function implemented on a 6800 microprocessor.

The concept of hash tables first appeared in the literature around 1953 but it is generally accepted that hashing was used prior to that. Other names given to the same process are scatter storage, randomized storage and key transformation table. These names will be seen to be equally applicable shortly.

Using the hashing technique, a symbol (collection of alphanumeric characters) to be put in the table is processed through a hashing function to obtain an index into a storage table. This index is then used for the address of a potential storage space for that symbol. We say potential because it is possible that some other symbol could have previously hashed to the same location. Such an occurrence is called a collision and the current symbol must be reprocessed to generate a new table address which is again checked for being empty and so on until an opening is found.

When it is necessary to look up the value of a symbol a process similar to that above is performed. The symbol is processed through the same hashing function as before. Next the address is checked to make sure that it is not empty. If it is empty, the symbol is undefined. Now that we know a symbol is stored there, we must then check to see that it matches the symbol we are looking for because this may be a collision. If the symbols do not match, we have to rehash just as before until we find the symbol or an empty location.

It is possible, with a given set of symbols, a given hashing function and a specified table length, that trying to insert a particular symbol into the table will result in an infinite number of collisions indicating no empty spaces even though the table is not full. By the same token another symbol may take many attempts before being finally inserted.

It should be quite obvious that the ideal case would be an infinitely long table space. However, a real world compromise dictates that we "waste" a percentage of the table to keep the number of rehashes low. The trade-off is very evident. The lower the percentage of table utilization, the lower will be the number of collisions. As the percentage of table utilization increases, so will the number of collisions. Furthermore, the number of collisions, and therefore the number of rehashes, directly affects execution time. It's the old memory size versus speed trade-off once again. In practice, a reasonable compromise is to shoot for 50 to 80 percent table utilization and to determine the hash count (number of rehashes allowed) empirically. If the hash count is exceeded on a symbol insertion operation, the table is declared full, but on a symbol retrieval operation the symbol is declared undefined.

When the table size and hashing function are selected appropriately, the average number of hashes is generally less than $log_2\, n$ where n is the number of symbols in the table. Compare this to a linear search which averages $n/2$ comparisons. An average assembly language program will contain about 100 labels and symbols. Hashing would average about seven collisions while a linear list would require about 50 comparisons on the average.

The crux of the hashing matter is finding a good hashing function which will minimize collisions. The procedure for this usually involves some complex mathematical analysis based on the characters expected in the symbols and their relative frequency of occurrence. The optimum hash function generally ends up being division by certain prime numbers or some other equally awkward scheme (for a microprocessor).

As an alternative to this, I offer an empirically determined hashing function that works well within the confines of an assembler. The reason for using it, however, was logically derived and goes something

Listing 1: The assembly listing of the hash function and random number generator. If the first hash of a label does not work, the routine is entered a second time through the REHASH function. The random number generator generates a 24 bit random number which is used to determine the table location of the label.

```
                    *
                    *
                    * STORAGE
                    *
0020                       ORG   $20
0020                RNDM    RMB   3
0023                TBLADR  RMB   2
                    *
                    *
1000                SYMTBL  EQU   $1000
                    *
                    *
0100                       ORG   $100
                    *
                    *
                    ** HASH
                    * THIS ROUTINE PROCESSES THE SYMBOL POINTED TO BY X
                    * AND RETURNS THE ADDRESS OF A SYMBOL LOCATION OF
                    * THE 4K SYMBOL TABLE IN THE X REGISTER.
                    * IT IS UP TO THE CALLING ROUTINE TO CHECK THE
                    * VALIDITY OF THE SYMBOL LOCATION.
                    *
                    * REHASH IS THE ENTRY POINT IF A RETRY IS NECESSARY
                    *
                    * THE B REGISTER CONTAINS THE HASH COUNT (THE
                    * NUMBER OF TIMES HASH + REHASH HAVE BEEN CALLED).
                    *
0100 5F             HASH    CLR B                 SET HASH COUNT TO 0
0101 A6 00                  LDA A  0,X            GET FIRST CHAR
0103 AB 05                  ADD A  5,X            FOLD THE SYMBOL TO 3 BYTES
0105 97 22                  STA A  RNDM+2
0107 A6 01                  LDA A  1,X
0109 A9 04                  ADC A  4,X
010B 97 21                  STA A  RNDM+1
010D A6 02                  LDA A  2,X
010F A9 03                  ADC A  3,X
0111 97 20                  STA A  RNDM           FOLD DONE
                    *
                    *
0113 5C             REHASH  INC B                 UP THE HASH COUNT
0114 BD 01 2C               JSR    RANDOM         GENERATE RANDOM BITS
0117 96 22                  LDA A  RNDM+2         GET A BYTE OF RANDOM
0119 94 0F                  AND A  $0F            MASK OFF 4
011B 36                     PSH A                 SAVE TILL LATER
011C 96 21                  LDA A  RNDM+1         GET ANOTHER BYTE
011E 94 F8                  AND A  $F8            MASK OFF 5 (9 BITS TOTAL)
0120 8B 00                  ADD A  #SYMTBL        ADD TO LS HALF
                    *                             OF SYMBOL TABLE ADDRESS
0122 97 24                  STA A  TBLADR+1       SAVE
0124 32                     PUL A                 GET FIRST BYTE BACK
0125 89 10                  ADC A  #SYMTBL/256     ADD TO MS HALF OF
                    *                             SYMBOL TABLE ADDRESS
0127 97 23                  STA A  TBLADR         SAVE
0129 DE 23                  LDX    TBLADR         GET ENTRY ADDRESS
012B 39                     RTS                   DONE
                    *
                    *
                    ** RANDOM
                    * THIS ROUTINE RETURNS A 24 BIT RANDOM
                    * NUMBER IN RNDM THROUGH RNDM+2 WHICH MUST BE
                    * NON-ZERO UPON ENTRY.  THE ROUTINE MAKES 24
                    * PASSES TO INVOLVE ALL BITS OF THE SEED IN
                    * THE RESULT.
012C 36             RANDOM  PSH A
012D 37                     PSH B                 SAVE REGS
012E C6 18                  LDA B  #24            GET LOOP COUNT
0130 96 20          RNDLP   LDA A  RNDM           GET MS BYTE
0132 49                     ROL A
0133 49                     ROL A
0134 49                     ROL A
0135 49                     ROL A
0136 49                     ROL A
0137 98 20                  EOR A  RNDM           XOR BIT 18 WITH 23
0139 49                     ROL A                 PUT RESULT IN CARRY
013A 79 00 22               ROL    RNDM+2         SHIFT IT IN
013D 79 00 21               ROL    RNDM+1         PROPAGATE ACROSS
0140 79 00 20               ROL    RNDM           ALL THE WAY
0143 5A                     DEC B                 PASS DONE
0144 26 EA                  BNE    RNDLP          LOOP TILL DONE
0146 33                     PUL B
0147 32                     PUL A                 RESTORE REGS
0148 39                     RTS                   DONE
                    *
                    *
                    *
                            END
        NO ERROR(S) DETECTED


   SYMBOL TABLE:
HASH     0100        RANDOM  012C        REHASH  0113        RNDLP   0130
RNDM     0020        SYMTBL  1000        TBLADR  0023
```

like this: it is the purpose of hashing to randomly distribute symbols about a table; why not then use a random number generator to generate the table index?

The random number generator, RANDOM, and the HASH routine used are shown in listing 1. The random number generator uses the maximal length sequence generator technique to generate a 24 bit random number. With a nonzero initial state in the three bytes, each call to RANDOM will leave them in a specific final state. Different initial states produce randomly different final states.

The HASH routine merely loads the three bytes with the symbol and calls RANDOM to generate a random bit sequence. The assembler for which HASH was written allowed six character symbols. In order to utilize every bit of symbol information to hash to an address, the six character symbol is crammed into three bytes by "folding" it in half. This is done by adding the outermost bytes (characters) together for one byte of the random number generator followed by adding together the next outermost two characters and lastly the innermost two. This can be done without losing information because the ASCII characters of the symbols have a hexadecimal value less than 7F. Two of these added together have a value less than hexadecimal FE which fits in eight bits.

The HASH routine in listing 1 assumes a 4 K byte symbol table limitation. With six bytes for the symbol name and two bytes for its value this allows 512 symbol spaces. This being the case, only nine bits are needed for a table index. Since the result of the call to RANDOM is 24 random bits we are perfectly free to choose any nine of those bits for the index. HASH does this by taking out the most significant nine of the least significant 12 bits of the generator.

Recall that HASH only returns a *potentially* useful table address. In the case of a label insertion operation it is up to the calling routine to check that the returned address is empty. If not, REHASH is called which utilizes the last contents of the random number generator as a seed for the next random number. Calling HASH again will produce exactly the same address. Alternate means of handling collisions such as linear or quadratic distribution will not be discussed here.

In the case of a label retrieve operation

the calling routine needs to check if the symbol matches that at the table address. If they do not match and the location is not empty, REHASH until the hash count limit is exceeded or an empty location is found whereupon the symbol is declared to be undefined. Note that it will take exactly the same number of attempts to find a symbol as it did to put it in the table to begin with.

This has by no means been a thorough treatment of the subject of hashing but only an attempt to pass on something which works rather well in my experience. The interested reader is encouraged to do further research into the topics mentioned here.■

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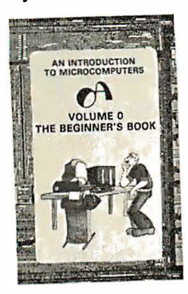
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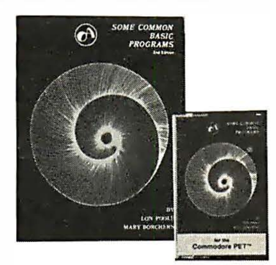
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S1025

Budget Building on a Bare Board

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For the experimenter with an eye toward saving a little money or who has a well-stocked parts cabinet, the thought of buying a blank computer board can be very appealing. It is now possible to assemble an entire S-100 computer system using your own parts and commercially designed printed circuit boards which are offered with complete documentation but with no parts. Table 1 indicates how this could be done. Even if you would rather assemble an SS-50 (6800 processor) system, read on anyway since much of what is said will apply to bare boards for those systems too (even though the selection of bare 6800 based computer boards is somewhat limited at present). Savings sometimes reach as much as 30 to 50 percent over the purchase price of a kit or an assembled board if parts are purchased carefully and only as needed. Three companies, Cybercom, Solid State Music (now SSM) and Ithaca Audio, offer low cost bare printed circuit boards for S-100 experimenters who are willing to do a little shopping for parts bargains and still have a professionally designed system.

I would like to summarize a few of my experiences assembling bare computer boards. It can be a rewarding endeavor if a few minor pitfalls are avoided.

About the Author

Dan S Parker works with microcomputers as a hobbyist (with an Altair 8800a), and in his research works as a doctoral student in the Physics Department of the University of California at Davis. He has developed a disk based 8080 data acquisition system for on and off line data retrieval and plotting of cryogenic experiments on magnetic phenomena of rare earth crystals.

Documentation and Software

Have you ever tried to assemble a circuit board with no parts layout, schematic, silk screen mask, or other documentation? Of course it would be impossible. All blank boards come with some form of documentation as just mentioned. Normally it consists of the preceding, plus a sheet or two of instructions on how to assemble the board. Don't expect elaborate and expensive manuals with your board. My experience has been that the documentation included with most bare boards is adequate for those who have already assembled one or more kits and who have the basic skills.

Many companies also offer the documentation packages for their boards as separate packages, usually priced at a dollar or so to cover printing and mailing costs. If you're really interested in a board, this is a very good investment. Always ask if the documentation can be had separately—this isn't always advertised.

Some types of computer cards demand that software support be provided. Foremost among these are video display and modem boards, which usually require a driver program to communicate with the interface. All such bare boards that I've seen offered include such software, although usually only in a hard copy source form which must be relocated or loaded in by hand.

About the Table

Table 1 lists some of the bare S-100 compatible boards on the market today. A few words are in order concerning the bare board tabulation. Many companies act as distributors for boards produced by other manufacturers. The table attempts to list only the main or representative distributor of the product. Prices can change rapidly, and different dealers may offer the same board for varying prices. A very handy address reference to these companies and a listing of hobby computer products which contains many of the boards listed in table 1 can be had by sending a business size, self-addresed, stamped envelope to S-100 Reference List, c/o Robert Elliott Purser, POB 466, El Dorado CA 95623.

Dealer Liability and Warranty

Almost without exception, you take a risk in purchasing a blank board if something goes wrong. The same is true of buying a complete kit. The adage "you get what you pay for" is certainly true in the bare board business. Dealer liability is limited to the replacement of the board if it proves defective. Any parts, such as sockets, that can't be salvaged if the board proves defective in design or manufacture are the burden the buyer must accept. Be sure you understand the limits of the warranty that the dealer offers. Also keep in mind that the dealer has no control over the quality of parts with which you choose to populate your board nor the care you take in its assembly. As a result, he or she is much less likely to provide extensive support or advice. I much prefer purchasing bare boards from companies that also offer kits and assembled versions of the same board.

Buying Parts

Purchasing parts for a blank board can be a real education. Assuming a parts list is in hand, it is a small chore to look through the prices in the advertisements, choosing which parts to order from which company. Limit yourself to purchases from no more than two or three companies if you can. If you've

had trouble or have heard of others having trouble locating a part, call the company that lists that part in their catalog and ask for a stock check. It's nice to do business with a company that has a toll free telephone number.

Often you can save money on parts and increase your spare parts supply at the same time. Pull-up resistors and bypass capacitors are two items that are needed in quantity. For example, I recently finished a board that needed 40 4.7 K ohm resistors, which were priced at 5¢ each for a total of $2. But the same company offered a package of 100 resistors of any one value for 1.7 cents each, totalling $1.70. It doesn't take much to figure out the better deal. The disk ceramic capacitor often used for noise bypass on

Table 1: A summary of available blank boards and where to obtain them.

	Description	Bare	Partial	Company	Comments
Programmable Memory Boards	32 K static	$38.00		F Reichert Sales	
	#300 (8 K)	22.50		Electronic Systems	
	8 K	29.95		Digital Research (Texas)	
	8 K	25.00		Jade	
	MB-4 (4 K)	29.95		Cybercom	
	MB-6A (8 K)	29.95		Cybercom	
	MB-7 (16 K)	29.95		Cybercom	
	MEMI (8 K)	25.95		Wameco	
	8 K	25.00		Ithaca Audio	
	16 KDR	35.00		Ithaca Audio	16 K and 64 K dynamic
	8 K	29.95		Barnes Electronics	
	16 K	35.00	88.00	Digital Micro Systems	
	LOGOS-1 (8 K)	21.95		Advanced Computer Products	
	32 K	59.95	99.95	Advanced Computer Products	
	8 K	29.00		Duston	
Processor Boards	8080A	34.95		Advanced Computer Products	
	8080A	30.00		Jade	
	8080A	25.95		Wameco	
	Z-80	35.00		Jade	
	Z-80	34.95		Advanced Computer Products	
	CPZ80	35.00		Ithaca Audio	
	6800	30.00		MRS	
	6502	39.95		CGRS Microtech	
Input/Output	MFIO-1	49.95		MSD	Multi-I/O
	TIDMA	35.00		Electronic Systems	Cassette I/O
	80-103A	49.95		DC Hayes	Modem
	IO-2	25.00		Cybercom	Parallel I/O
	IO-4	25.00		Cybercom	Serial and Parallel
	IA-1100	25.00		Ithaca Audio	64 by 16 Video
	VB-1B	29.95		Cybercom	64 by 16 Video
	SCT-100		95.00	Xitex Corp	64 by 16 Video and Parallel port
	Master I/O	47.50		Space Time Products	Serial, Parallel, Programmable and Read Only Memory
	Tarbell	40.00		Tarbell Electronics	Disk Controller
Read Only Memory	16 K		57.50	Digital Research (Texas)	2708s
	JG 8/16	30.00	59.95	Jade	2708/2716s
	EPM-1	30.00		Wameco	4 K 1702As
	EP 16 K	25.00		Ithaca Audio	2708/2716s
	4 K	29.95		Barnes Electronics	
	Bytesaver		136.00	Cromemco	8 K 2708s
	Byteuser	24.95	64.95	Advanced Computer Products	8 K 2708s
	MB-3		64.95	Cybercom	2 K/4 K 1702As
	MB-8		84.95	Cybercom	8 K/16K 2708s memory
	MB-9		72.00	Cybercom	Also programmable
	32K	30.00		Wameco	2708/2716s
Mother Board	13 slot	35.00		Jade	
	15 slot	40.00		Cybercom	
	11 slot	29.50		Vector Electronic	Active terminations
	20 slot		76.00	Thinkertoys	Active terminations
	18 slot	29.95		California Industrial	Active terminations
	12 slot	35.00		Wameco	Active terminations
Miscellaneous	Better Bug Trap		45.00	Micronics	
	Real Time Clock	30.00		Wameco	
	CompuTime CT100	80.00		CompuTime	
	S-4 Front Panel		20.00	Sargents Distributors	I/O and read only memory
	Digital/Analog	34.00		Pinnacle Products	
	Buss Terminator	21.95		VAMP	

memory boards is another item that is sometimes more cheaply purchased in bulk, especially the 0.1 and 0.01 μF varieties. 14 and 16 pin socket prices really start to drop if you buy in slightly larger quantities, too.

One rule of thumb holds true: it only takes one back ordered or hard to find part to keep your board inoperable. A catalog listing of a part does not necessarily indicate that that company has those parts.

Why Companies Sell Blank Boards

You might think that a company marketing bare boards as well as kits and assembled units would be competing against itself, particularly since you can almost always save money over the kit price by purchasing your own parts separately. Volume and exposure seem to be the two big reasons. First, circuit boards, like everything else, are cheaper in larger production runs. Selling off the extra boards for a proven product reaches the additional market of do-it-yourself computerists who like to go to the extra trouble of purchasing parts separately for the promise of saving a few dollars. Secondly, marketing the bare board doesn't increase the support demand at nearly the rate that support must be provided to the kit or assembled board purchaser. Finally, for some types of boards, exposure can be increased dramatically by offering the board blank. A case in point is the D C Hayes modem board listed in Table 1. Offering it bare significantly increases the number of people who have the board. Wide customer acceptance and use is what communications and computer interface standards are all about.

A Few Final Dos and Don'ts

Never undertake the project of populating a bare board without first obtaining a copy of the parts list and pricing the needed parts. Write or call the company and ask for a parts list in advance of purchasing the board. A self-addressed, stamped envelope when requesting the list is a nice gesture.

Don't get caught on a special "secret" deal of blank boards being dumped on the market because one of the chips it used is no longer available, or has become prohibitively expensive, or the board needs extensive foil cutting and jumpers to work. Buy bare boards as you would a kit or completed board: only from a reputable company.

Many companies offer "partial kits" which consist of the bare board and especially hard to find components, or, in the case of memory boards, 16 K byte and 32 K byte boards with only a partial complement of memory on them. Table 1 includes a column of some boards that are presently offered as partial kits. Plan ahead so that the parts will be there when you need them, and substitute parts sparingly. Don't buy more blank boards than you need right away, hoping to store the extras away for a rainy day. The market is changing too quickly. Most of the boards listed in table 1 have appeared within the last year. As an example, I purchased extra 4 K byte and 8 K blank memory boards over a year ago with the idea of slowly populating them with 2102 memory chips. The boards still sit gathering dust, obsoleted by the newer 16 K byte boards, and higher density, lower power, lower cost per bit memory chips. It's not cost effective to populate my old boards anymore.

Buying and populating blank boards can be a significant money saver. I figure that, having populated about a dozen bare boards in the past two years, my savings have equalled at least the price of a fully populated 16 K byte memory board, if not more. In almost all cases, I would never have been able to afford the cash outlay for such a board if it were only offered as a kit or fully assembled. Spend a little time considering the above, and you'll be generously rewarded in savings on your board purchase. For more information about the companies in table 1, contact me or your local computer store.■

BYTE's Bugs

Pseudorandom Errors

A typographical error occurred in 2 program listings in the article "Three Types of Pseudorandom Sequences" by C Brain Honess in the June 1979 BYTE, page 234. In listing 1 on page 236, line 150 should have been:

```
150 LET A = N/10000.
```

In listing 2 on page 238, line 200 should have read as follows:

```
200 PRINT "DEGENERATION AFTER"; I; "NUMBERS."
```

A note on a BOMB card mailed from Greenville SC brought these errors to our attention.

Marsport Bugs Defeated

Dr Reimut Wette has informed us of several typographical errors which occurred in "Marsport, Here I Come" (April 1979 BYTE, page 84). The corrected segments of code for listing 1 are shown here circled.

```
024    *LBLA
025    STOI
026    *LBL0
027    GSBd
028    CF0

114    *LBLc
115    →P
116    R↓
117    X⇄Y
118    R↓
119    →P
120    RTN
121    *LBL4
122    7
123    X⇄I
124    STO0

201    9
202    x
203    STO7
204    GSBC
205    ÷
206    STO1
207    STO2
208    STO3
```

Gravitational Problems

Mr Hinrichs seems to have developed a much better than average planetary landing program ("Marsport, Here I Come," April 1979 BYTE). He is especially to be congratulated on his adaptation of the physics of celestial mechanics to a program on a programmable calculator! However, on page 100 he has made a common physics error in saying, "The attraction of gravity is exactly balanced by the centrifugal force at all times." The attraction of gravity is not balanced by anything. In fact, if it were balanced at all times, it would not have any effect and there would be no orbit — only straight line motion at constant speed. What Mr Hinrichs in his equations on page 104 implies is that the attraction of gravity interferes with the tendency of a body to maintain a constant speed and direction just enough to continuously change the direction (circular orbit) without changing the speed. This is true only for a circular orbit. In other cases, the unbalanced force of gravity can change speed as well as direction.

Fortunately this confusion between inertia and a force (called centrifugal) has no effect on the workings of what is an excellent program.

Robert Reiland
RD #1
Portersville PA 16051 ■

Clubs and Newsletters

DIRECTORY

The following is the third BYTE Clubs and Newsletters Directory. The directory was compiled from information supplied by the various clubs listed. A form was sent to all clubs and newsletters listed in the second directory requesting up-to-date information. If the form was not returned, we deleted the club from the third directory. In addition, the listing was correlated with back issues of the magazine and materials on file in the BYTE offices. If information is missing in one or more categories, it means the data was not provided. We will be keeping the file available and updating it for the next directory; so, if there are errors or if you have a new club which has just been formed, send the information to: Laura Hanson, Clubs and Newsletters Editor, BYTE Publications Inc, 70 Main St, Peterborough NH 03458.

The listings follow this form:

1. Name of organization
2. Mailing address
3. Meeting location
4. Meeting algorithm
5. Newsletter or publication
6. Contact person
7. Contact phone number
8. Dues or subscription fees
9. Special interests
10. Other comments

Clubs

Zips - 00000 - 10000

1. **MUMPS Users Group**
2. POB 208
Bedford MA 01730
3. 1978 Atlanta, 1979 San Diego, 1980 Cape Cod
4. Yearly in June
5. *MUG Quaterly*
6. R E Zapolin, Executive Director
7. (617) 271-2534
8. $25 per year
9. US Branch - Exchange of information among users of ANSI Std MUMPS (and older dialects), offer tutorials and publications on MUMPS language.
10. ANSI MUMPS is used world-wide on maxis, minis, microcomputers in medical, commercial and educational applications. A large number of public domain programs exist. A list of publications is available.

1. **New England Computer Society**
2. POB 198
Bedford MA 01730
3. Mitre Corp, Cafeteria, Rt 62, east of Rt 3, Bedford MA
4. First Wednesday of the month
5. *NECS Newsletter*
6. Dave Mitton, Secretary
7. (617) 493-3154 days
8. $6 per year
9. User Groups in PET, APPLE, 6800, Digital Group, and TRS-80.
10. Computerized Bulletin Board System (CBBS), (617) 864-3819.

1. **TRUGEM (TRS-80 Users Group of Eastern Massachusetts)**
2. 61 Lake Shore Rd, Natick Ma 01760
3. Cochituate MA (call or write first)
4. Second Wednesday of each month at 7 PM
5. *The TRUGEM Newsletter* (monthly)
6. A Richard Miller, President
7. (617) 653-6136 (9 AM to 9 PM)
8. $10 per year local or remote. Send fees to: Ed Robinson, TRUGEM Treasurer, 11 Leighton Rd, Auburndale MA 02166.
9. TRS-80 hardware and software; peripherals from Radio Shack and independents; Programs Exchange Library (noncommercial); demonstrations and sales of commercial hardware and software encouraged.
10. Meeting monthly since January 1978. All TRS-80 users are invited to attend.

1. **The Boston Computer Society**
2. 17 Chestnut St, Boston MA 02108
3. Commonwealth School, 151 Commonwealth Ave, Boston
4. Fourth Wednesday of the month at 7 PM
5. *The BCS Update* (an enormous publication with nation-wide industry exclusives and news of New England)
6. Jonathan Rotenberg
7. (617) 227-9178
8. $10 per year (includes all subgroups)
9. User Groups: PET, Sorcerer, OSI and North Star. Subgroups: education, business applications, Pascal and beginner tutorials. Others on the way.
10. A complete resource center for the microcomputer industry which, in addition to running meetings and publishing a newsletter, publishes books, runs trade shows, other seminars and provides a free consulting and problem solution service by phone.

1. **TRS-80 Club of Arlington.**
2. 96 Dothan St, Arlington MA 02174
3. Same as above
4. Write for details
5. Yes; send $1 donation and 2 long, self-addressed, stamped envelopes for 2 issues.
6. Poi Pow
9. TRS-80 disk business software; library includes: data base management, word processor, inventory, mailing list, stock, accounting, etc.
10. Interested in good business software at lowest costs; we review business software written for the TRS-80. No games. We review new developments in software and hardware for the small business system.

1. **RICH (Rhode Island Computer Hobbyists)**
2. POB 599, Bristol RI 02809
3. Various locations around Providence
4. Third Tuesday of the months of March, April, May, June, September, October, November
5. Yes
6. Emilio D Iannuccillo
7. (401) 253-5450
8. $3 per year
10. We are a small active group dedicated to keeping abreast of current technology, plus lending a hand to each other regarding hardware and software. We also give help and advice to new comers into the world of microprocessors.

1. **Connecticut Computer Club**
2. c/o Leo Taylor, 18 Ridge Ct W, West Haven CT 06516.
3. Suffield Library, Suffield CT 06708
4. First Thursday of each month
5. *Connecticut Computer Club Newsletter*
6. Leo Taylor, Secretary
7. (203) 389-6551
8. 1980 dues $6
10. We have 2 talks per meeting; generally one on software and one on hardware. The club does not specialize on any one machine. We have 65 members at the moment with a turn-out of about 40 per meeting. The club was featured in the first issue of *onComputing* magazine in an article by one of our members.

1. **Amateur Computer Group - New Jersey Inc**
2. U.C.T.I. 1776 Raritan Rd, Scotch Plains NJ 07076
3. Union County Technical Insitute, Rutgers University, County College of Morris and Middlesex County College.
5. *ACG-NJ News*
6. Sol Libes or Marty Nichols
7. (201) 277-2063 or (201) 361-7180, respectively
8. $8 per year
9. Have following User Groups: 8080/Z80; 6800; KIM; TRS-80; PET; Apple; and Pascal.
10. Run classes and have software libraries; publish annual membership directory; over 1000 members; annual "Trenton Computer Festival" held at the end of April with a 5 acre computer flea market. Chapters in Morris and Ocean counties.

1. **Data Processing Club**
2. c/o Dennis M Lloyd Business Studies Division Gloucester County College, Tanyard Rd, Sewell NJ 08080
3. Same as above
6. Dennis M Lloyd
7. (609) 468-5000 Ext 242
8. $5
9. All data processing areas.
10. We wish to expand data processing education outside of the classroom.

Zips - 10000 - 20000

1. **Microcomputer Business Users Group**
2. 161 W 75 St, New York NY 10023
3. Baruch College, Manhattan
4. Third Thursday of the month
5. *BUG Newsletter*
6. Dr Laird Whitehill
7. (212) 580-3589 (re:*BUG*)
8. No dues, subscription $10 for '79
10. A group for vendors of software and users of software who are serious about using or vending microcomputers for business purposes. Guest lecturers and panel discussions concentrate on application and system software evaluations, as well as such topics as how to develop and sell microcomputer software products. Group publishes a newsletter which keeps those who did not attend informed about meeting content and exact place of next meeting.

1. **Long Island Computer Association**
2. 35 Irene Ln E, Plainview NY 11803
3. New York Institute of Technology
4. Second Friday of the month for the 8080 subgroup; third Friday of the month for the regular meeting and subgroups
5. *The Stack*
6. Aileen Harrison
7. (516) 938-6769
8. $10 per year
9. Pascal, 8080, 6800, PET, TRS-80, North Star, etc.
10. We meet the third Friday of the month with guest speakers, show and tell, hands-on demonstrations etc. We have many subgroups, and have 170 members.

1. **Mohawk Valley Microcomputer Club**
2. POB 331, RFD 1, W Carter Rd, Rome NY 13440
3. Varies
4. Third Tuesday of the month
5. *Micros Along the Mohawk*
6. Mike Troutman
7. (315) 336-0986
8. $2 per year (includes newsletter)
9. Several special interest groups: 6800, 8080/Z80, and beginners.
10. Membership of approximately 100. Very high predominance of SwTP 6800 systems (=75% versus 25% for all others).

1. **Apple Byter's Corps**
2. 225 Walton Dr, Snyder NY 14226
3. Buffalo Savings Bank, Sheridan-Harlem Branch, 3980 Sheridan Dr, Amherst NY 14226
4. Every third Friday at 7:30 PM
5. Monthly, no particular title
6. Gary Weir, President and typist
7. (716) 839-3486
8. $10 per year
9. Exchanging programs; helping new Apple II owners. We have begun a computer network and special interest groups in assembly language programming and computer-assisted instruction programming. Newsletter enhancement is the current rage.
10. We are growing too quickly to settle on any firm objectives (as our numbers grow, so do our problems and potentials). We do want growth, but could use the help of well-established, similar groups.

1. **Rochester Area Microcomputer Society (RAMS)**
2. POB Drawer D, Rochester NY 14609
3. Rochester Institute of Technology Room 1030 Bldg 9
4. Second Thursday of each month
5. *Memory Pages*
6. Mike Ciaraldi
8. $7.50 per year (1978-1979)
9. URTH (University of Rochester FORTH), 6800/6809/68000 special interest group, and a Pascal interest group.
10. As a club, our largest problem is getting programs that most of the membership can run.

1. **AM-100 Users Group**
2. 616 Long Pond Rd, Rochester NY 14612
4. Local meetings arranged by invitation.
5. *Newsletter for AM-100 Users Group*
6. Lefford F Lowden
7. (716) 227-0841
8. $15 in US and Canada, $36 International
9. System software and user developed software; bugs and their fixes; programming techniques; and feedback among members.
10. Aimed at owners, users, and potential owners of the Alpha Microsystems AM-100 computer system.

1. **Central Pennsylvania Computer Club**
2. 3263 Bull Rd, York PA 17404
3. Varies, York-Lancaster area
4. Third Friday of even months, and the fourth Wednesday of odd months
5. *Data Dump*
6. Cletus Hunt III, York area Joseph Pallas, Lancaster area
7. (717) 764-4977, (717) 569-3137 respectively
8. Currently being re-evaluated
9. Many 6800 users, but no organized special interest group.
10. Emphasis is on informal exchange of information among club members and display of members' computers.

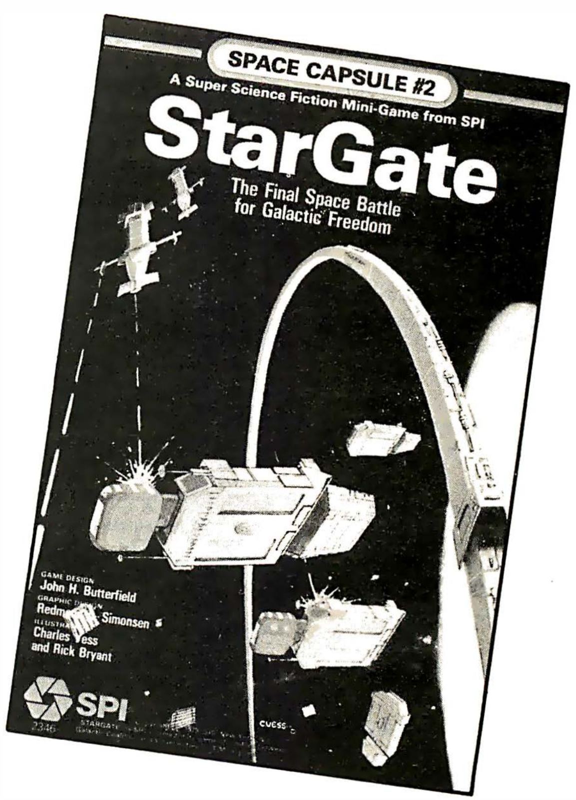
1. **Philadelphia Area Computer Society (PACS)**
2. POB 1954, Philadelphia PA 19105
3. LaSalle College Science Building
4. Third Saturday of each month
5. *The Data Bus* (monthly)
6. Dick Moberg
7. (215) 923-3299
8. $10 per year, $5 for students
9. Subgroups in the following areas: Apple; TRS-80; PET; Robotics; spaceflight simulation; and others. Courses in BASIC; Pascal; home-brewing; computers for kids; Selectric repair; and others.
10. Current membership is approximately 350. Average meeting attendance is over 100 people. Meetings consist of courses and subgroups followed by the main meeting at 2 PM. A mini flea market and mapping session follow the meeting. For more information call the PACS Hotline (215) 925-5264.

ZIPS 20000-30000

1. **Washington Amateur Computer Society**
2. 4201 Massachusetts Ave, #168, Washington DC 20016

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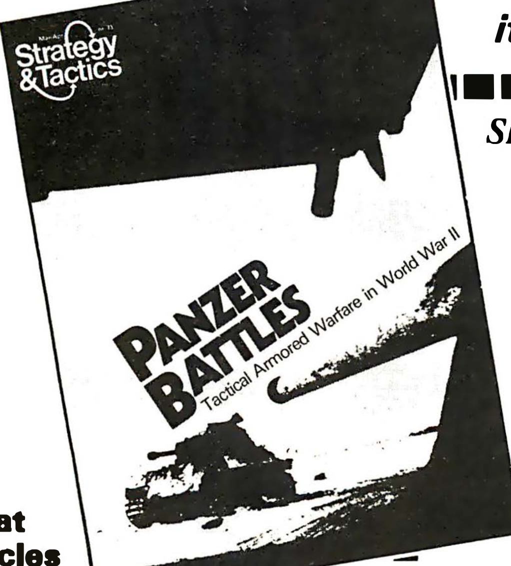
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Circle 331 on inquiry card.

3. First floor hall, Keane Hall, Catholic University of America
4. First Friday of the month at 7:30 PM
5. *JWAC*
8. $3.50 per year
9. Organized to provide a forum for the computer hobbyist and student of computing science.

1. **Amateur Radio Research and Development Corp (AMRAD)**
2. 1524 Springvale Ave, McLean VA 22101
3. Patrick Henry Branch Library, 101 Maple Ave E, Vienna VA 22180
4. First Monday of each month at 7:30 PM
5. *AMRAD Newsletter*
6. Paul L Rinaldo, President
7. (703) 356-8918
8. Regular $10; second in family $5; full-time students $2.
9. Computers and amateur radio.
10. AMRAD operates a Computerized Bulletin Board System (CBBS) in the Washington, DC area. Phone No. (703) 281-2125.

1. **Tidewater Computer Club**
2. 677 Lord Dunmore Dr, Virginia Beach VA 23462
3. Electronic Computer Programming Institute, Janaf Office Building, Janaf Shopping Center
4. First and third Tuesday of each month 7:30 PM
5. *Hardcopy* (quarterly)
6. C Dawson Yeomans, President
7. (804) 420-6379
8. 50¢ per month
9. A general interest in microprocessors. Club members own at least one of all major microprocessors. Subjects at meetings and special projects often are useful on many microprocessors.
10. Special interest classes precede each meeting at 6:30 PM. Special projects are conducted at times convenient to participants and are reported at meetings and in the *Newsletter*.

1. **Triangle Amateur Computer Club**
2. POB 17523, Raleigh NC 27514
3. Dreyfus Auditorium, Research Triangle Institute, Triangle Park NC
4. Last Sunday of the month
9. The club is dedicated to the advancement of interest in amateur or personal computing.

1. **Carolina Apple Core**
2. 5212 Inglewood Ln, Raleigh NC 27609
3. Different locations
4. Third Tuesday of the month
5. Yes
8. $5 per year

Zips 30000-40000

1. **Indian River Computer Society (IRCS)**
2. c/o Florida Institute of Technology (Electrical Engineering Dept) Melbourne FL 32901
3. Florida Institute of Technology Campus
4. Meetings are held twice a month
6. Lee Zaretsky
7. (305) 723-3701 (Electrical Engineering Dept Extension)
8. $2 per 10-week quarter
9. IRCS is dedicated to hobbyist microcomputers and their many applications.
10. Although IRCS meetings are geared to fit into the quarter schedule of the university, it does not mean that members must be students. Anyone interested in microcomputers is invited to attend our meetings and join if they like what they see.

1. **Space Coast Microcomputer Club**
2. 315 Inlet Ave, Merritt Island FL 32952
3. Merritt Island Public Library Auditorium
4. Fourth Thursday of each month
5. *Enterprise* (monthly)
6. Ray O Lockwood VP, Editor
7. (305) 452-2159
8. $5 per year
9. Primarily S-100 systems.
10. Affiliated loosely with Kennedy Space Center.

Circle 334 on inquiry card.



Software Tools

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- Commands include forward or backward Locate and Change, Insert, Delete, Replace, Inline, Input, Print, List, Window, Get, Put, Macro, Tabset, Append, Case, Scale, and Dump.
- Simple line-oriented commands with character string manipulation capabilities.
- Text may be located by string value, by line number, or by relative line number.
- Global string search and replace capabilities.
- Commands for moving, copying, and merging edit files on the same or different diskettes.
- Self-explanatory diagnostic messages.
- Single keystrokes for the most commonly used commands.
- Safeguards to prevent catastrophic user errors that result in loss of the edit file.
- Designed for today's high speed CRT's, video monitors, and teletypewriter terminals.
- Thoroughly field tested and documented with a User's Manual of over 60 pages.
- Compatible with existing CP/M edit files and derivative operating systems.

And remember — in today's interactive programming environment — the programmer's most important software development tool is the text editor. Our **ED-80 Text Editor** is working in industry, government, universities, and in personal computing to significantly cut program development time and high labor costs. Why not let **ED-80** begin solving your text editing problems today?

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master charge — BANKAMERICARD VISA

- ☐ Please send additional information.
- ☐ Send Diskette, User's Manual, and paid-up license agreement $99.00
  Specify SINGLE DENSITY Diskette size .... ☐ 5" ☐ 8"
- ☐ Send User's Manual (credited on purchase of a paid-up license) $10.00
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- ☐ Please charge to my creditcard............. ☐ VISA ☐ Master Charge

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® CP/M is a trademark of Digital Research

Circle 260 on inquiry card.

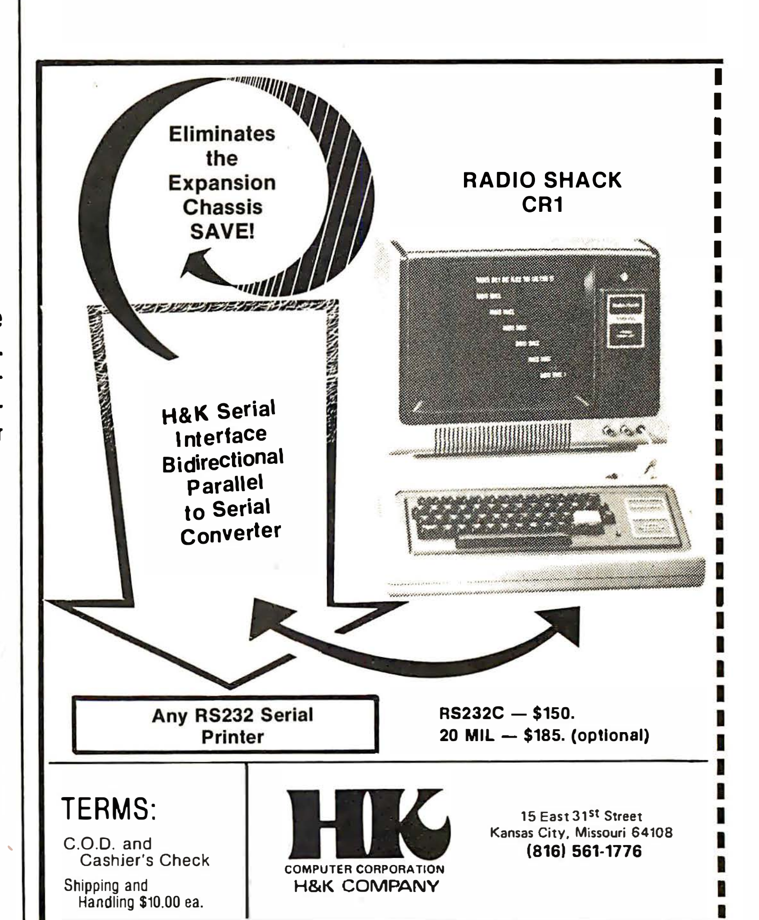


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We are 3 years old, and have close to 100 members.

1. **The Birmingham Microprocessor Group (BMG)**
2. 3548 Stonehenge Pl, Birmingham AL 35210
3. South Side library
4. Fourth Sunday of each month at 2 PM
5. *The Printout*
6. Tom Bowen
7. Home (205) 956-9576 Business (205) 870-1367
8. $6 per year
9. The BMG is a general interest organization with special interest as follows: Apple Corp — Apple II owners and users; TRS-Can—TRS-80 or Radio Shack Users; Hardware Hackers — Homebrew.
10. We currently have 116 members on the books with 25-30 being active participants in the general interest area and another 25 that are active in special interest activities.

1. **Central Alabama TRS-80 Computer Society**
2. c/o Lewis E Garrison, Secretary, 6375 Pinebrook Dr, Montgomery AL 36117
3. Normandale Community Center
4. Third Tuesday of each month
5. None
6. Lewis E Garrison or Walter Bray
7. (205) 272-8462 or (205) 272-3621 respectively
8. $2 per month or $24 per year
9. TRS-80

Zips 40000-50000

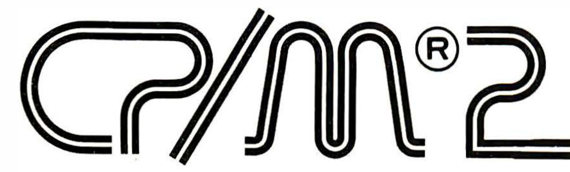
1. **Amateur Computer Society of Central Ohio**
2. 2589 Brookwood Rd, Columbus OH 43209
3. Center of Science and Industry
4. First Wednesday of each month
5. *I/O*
6. Fred Hatfield K8VDU
7. (614) 888-9287
8. $10 per year
9. Personal networks, computer chess, and graphics.

1. **Akron Digital Group**
2. 107 7th St NW, Barberton OH 44203
3. Kenmore Public Library, 2200 14th St SW, Akron OH
4. Fourth Wednesday of the month at 7 PM
6. Lou Laurich
9. The club programs are planned toward the small systems hobbyist with tips on programming and hardware application.

1. **Goodyear Computer Club**
2. c/o J F Derry D-109E PLT1, Goodyear T and R Co, Akron OH 44316 I McLeod or R Flower D-471 G3, Goodyear Aerospace Corp, Akron OH 44315
3. Goodyear Hall
5. *The Late Edition*
6. J F Derry or R Flower
7. (216) 794-4010 or (216) 794-3573 respectively
8. $10 per year
9. Hardware - modem design and building etc; investment analysis; new hardware/software developments; and education.
10. Personal computers used by members: TRS-80, Apple, OSI C28P, IMSAI, KIM, PET, Homebrews, North Star Horizon, RCA 1802, and M-6800. Have had joint meetings with Akron chapters of the Association of Computing Machinery (ACM) and the Institute of Electrical and Electronic Engineers (IEEE) Computer Society.

1. **Alliance Micromputer Club**
2. 3885 Norwood Ave, Alliance OH 44601
3. Harter Bank Community Room
4. First Tuesday of each month at 7 PM
5. None
6. Gary S Fix, President
7. (216) 823-8996
8. None
10. About 20 members currently with about half owning a personal microcomputer system including several TRS-80s.

1. **Dayton Microcomputer Association**
2. c/o Dayton Museum of



CONTROL PROGRAM FOR MICROCOMPUTERS

NOW BETTER THAN EVER

You've probably heard about CP/M. But if you haven't, it's the world's most popular operating system. CP/M is considered the "software bus" for 8080 and Z80 microcomputers because it gives you the hardware-independent interface you need to make your computer work for you. Because it's hardware-independent, you can get programming languages, word processing software, and business applications packages from scores of suppliers at affordable prices.

CP/M 2.0 is the latest in the evolution of a proven reliable and efficient software system. It's the kind of reliability that comes from five years of field testing in thousands of installations. And it's supported by an experienced staff dedicated to maintaining CP/M as the best product in the industry.

CP/M 2.0 gives you many new features, with an enhanced upward compatible file system, powerful new random access capabilities, and unprecedented field alteration facilities which allow you to tailor CP/M 2.0 to manage virtually any disk subsystem. From minidisks, floppy disks, all the way to high-capacity hard disks, the flexibility of CP/M 2.0 makes it a truly universal operating system. Get yourself or your company on the software bus: contact us for further details, or ask your dealer about CP/M 2.0 availability for your computer.

DISKETTE and DOCUMENTATION
Single Quantity Prices: $150



MULTI-PROGRAMMING MONITOR

NEW INDUSTRY STANDARD

Digital Research announces a deluxe operating system that provides big computer facilities at small computer prices. MP/M is a monitor program which operates with your microcomputer to provide multi-terminal access with multiprogramming at each terminal. Best of all, it's CP/M compatible which means you can run a wide variety of programming languages, applications packages, and development software.

If you want, you can run simultaneous editors, program translators, and background printer spoolers. Or you can use MP/M for data entry or data-base access from remote terminals. Or you can use MP/M real-time features to monitor an assembly line and automatically schedule programs for execution throughout the day. MP/M makes an excellent focal point for a cluster of connected microcomputers. The possibilities are limitless.

Like CP/M, MP/M is especially built to adapt to most 8080 or Z80 microcomputers, with an 8086 version on the way. You can operate your I/O devices either interrupt-driven or polled, and you can even write your own system processes which are combined with MP/M through a simple system generation. It's an exciting new product from the most experienced systems software supplier in the microcomputer industry. Contact us for details, or ask your dealer about MP/M availability for your computer system.

DISKETTE and DOCUMENTATION
Single Quantity Price: $300



Post Office Box 579
Pacific Grove, California 93950
(408) 649-3896

Circle 95 on inquiry card.

Natural History, 2629 Ridge Ave, Dayton OH 45414
3. Same as above
4. Last Tuesday of the month at 7:30 PM
5. *DMA Data Bus*
6. Dan Watson
7. (513) 223-2348
8. $10 dues
9. 8080 Users - First Sunday 1 PM - 274-1149; 6800 Users - First Tuesday, 7 PM - 435-9297; 6502 Users - First and Third Monday, 7:30 PM -426-7711; TRS-80 Users (DARSUG) - call for time and place -426-1601; Apple II Users -Second Wednesday 7:30 PM -223-2348.
10. A special session for novices is held at 6 PM immediately before the regular meeting on the last Tuesday of the month. All other special groups meet at various locations - call for information. Visitors always welcome.

1. **Evansville Computer Club**
2. c/o National Sharedata Corp, POB 3895, Evansville IN 47737
3. Blind Association, Second Ave and Virginia
4. Second Wednesday of the month at 7:30 PM
6. Robert Heerdink
7. (812) 426-2725
9. The group is varied with interest in several types of microcomputers.

1. **Purdue University Computer Hobbyist Club (PUNCH)**
2. Rm 67 Electrical Engineering Building, West Lafeyette IN 47907
3. Rm 117 Mathews Hall
4. Mondays at 7 PM
5. None
6. John Eaton
7. (317) 742-8521
8. None at present
9. Various microcomputer systems; predominately M6800 users.

1. **Detroit Personal Computer Network**
2. 13043 McNichols, Detroit MI 48219
6. Andrew Fellman
7. (313) 865-4374
9. This organization was formed to help microcomputer users discover and exchange ideas on user projects, to promote business or financial gain, and for enjoyment.

1. **Educational Recreational Computer Club**
2. c/o Paul Heimnick, 1415 Olmstead St, Owosso MI 48867
3. Salvation Army, 302 E Exchange St, Owosso
5. *ERCC Newsletter* (monthly)
6. Paul Heimnick, President
7. (517) 723-7602
8. Dues $5 per year/$2.50 subscription for 1 year
9. Emphasis on TRS-80 to help educate others about computing.

1. **Battle Creek Area Microcomputer Club**
2. 8587 Q Dr N, Battle Creek MI 49017
3. Pennfield High School (above address)
5. Yes
6. Jeff Stanton
7. (616) 763-9685
8. $1 periodically (for stamps)
9. Mostly TRS-80 owners.
10. Club library open to members. 50¢ per program copying fee. Cassettes and diskettes are sold at a discount through the club. Meetings consist of short presentations on BASIC or machine language, some program swapping, and equipment and software demonstrations.

Zips 50000-60000

1. **Eastern Iowa Computer Club**
2. POB 164, Hiawatha IO 52233
3. REC building in Marion
4. The last Sunday of the month at 7 PM
5. Yes
6. Mark Bergemann
7. (319) 377-1959
8. $10 per year
9. Just started bit-slice microprocessor special interest group with plans to build one sometime in the future.
10. Working on a club

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Both systems are available in a variety of CP/M, diskette size and density formats including IBM 8"; North Star; Micropolis; TRS-80; Processor Tech Helios II; Altair; iCOM; Dynabyte; Imsai; and others.

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Or order direct from

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9807 Davona Drive, San Ramon, CA 94583
(415) 828-6697

Circle 213 on inquiry card.

modem to use in a personal computer network.

1. **Fox Valley Computer Society**
2. POB 2742, Appleton WI 54913
3. Room D-104, Fox Valley Technical Institute
4. Second Tuesday of the month
6. Daniel K Dannells
7. (414) 734-7161
8. $5 initially
9. Diversified.

1. **Mini 'App'les**
2. 13516 Grand Ave S, Burnsville MN 55337
3. Minnesota Federal Savings and Loan, Hopkins MN
4. Third Wednesday of the month
5. *Mini 'App'les*
6. Daniel B Buchler, President
7. (612) 890-5051
8. $10 per year
9. Apple users group; user contributed program bank; monthly meeting and program; games; business; computer-assisted instruction; word-processing; and documentation distribution.
10. Users group covers the twin cities of Minneapolis and St Paul metropolitan area. 'Local' members live roughly within a 100 mile radius. Newsletter subscribers are in all parts of the country.

1. **Minnesota Computer Society**
2. POB 35541, Minneapolis MN 55435
3. Future location to be announced
5. *MCS Newsletter*
6. Jean Rice
7. (612) 941-1051
8. $7 regular; $3 student
9. Special interest group projects; general interest computer presentations; technical presentations; presentations to civic groups.
10. Our meetings consist of general business speakers, show and tell, and special interest groups.

1. **XXX-11**
2. 514 So 9th St, Moorhead MN 56560
3. Moorhead MN
4. First and third Wednesdays of the month
5. *XXX-11 Newsletter*
6. C R Corner
7. (218) 233-7894
8. $9 per year
9. Languages.

Zips 60000-70000

1. **CACHE (Chicago Area Computer Hobbyists Exchange)**
2. POB 52, South Holland IL 60473
3. Northern Illinois Gas Building, Golf and Shermer, Glenview
4. Third Sunday of the month, main meeting at 1 PM
5. *CACHE Register*
6. POB 52
7. Recorder on (312) 849-1132
8. $10 per year
9. Business; TRS-80; C P/M; communications; Northstar; PET; Apple; LSI-11; robotics; ham; Pascal; programming languages (not BASIC or Pascal).

1. **Microprocessor User Group**
2. 641 Woodlawn, Aurora IL 60506
3. Fermi National Accelerator Laboratory, Hi-Rise, Main floor, SW meeting facility
4. Third Monday of the month at 8 PM
6. Mike Urso
9. Primarily an Apple user group, but we include all processors in discussions.

1. **Chicago TRS-80 Users Group**
2. 3950 N Lake Shore Dr, Apt 2310, Chicago IL 60613
4. Third Wednesday of the month
5. Yes
6. Emmanuel B Garcia Jr
8. $9 per year

1. **QuadCity Computer Club**
2. 4211 7 Ave, Rock Island IL 61201
3. Rock Island Arsenal
4. First Sunday of the month at 7 PM
5. *QC³ News*
6. John Greve

Circle 134 on inquiry card.

7. (309) 786-8187
8. $6 per year
9. We cater to all brands of computers and deal with software and hardware.

1. **St Louis Area Computer Club Inc**
2. POB 28924, St Louis MO 63132
3. Thornhill Branch of St Louis County Library, Fee Fee and Willowyck Roads
4. First Thursday of month at 7 PM
5. *SLACC Stack*
6. Noel Moss
7. Days (314) 862-4040 or (314) 367-3189 evenings
8. $5 per year
9. 8080 homebrew; modems; and data communications and networking; 1802 group; TRS-80 group; Pet group; and Apple group.
10. Club serves as an information clearing house. Approximately ⅓ of the members own 6800 systems; the balance have other processors, especially 8080/Z80 and 650X. Our meetings consist of club business, a formal presentation, and a rap session.

1. **Silly-Corn Hills Computer Club**
2. 2145 W Central Ave, Springfield MO 65802
3. Varies. 16 main meetings a year and section meetings
5. *ASCII Code* (Association of Computer Interested Individuals)
6. Andrew A Griffin, Secretary
7. (417) 866-2447 (8 to 4 PM central time)
8. Area computer users $12 per year. Computer users outside SW MO and nonuser interested persons $7 per year
9. All phases of computer use; relationship to computers in all phases of human life; 7 computer users groups; 9 computer applications groups (games to medical systems); 4 computer related interest groups (history, public access, programmable calculators, and grievance ombudsman). Broadly varied membership includes all types of users.
10. Plans for September 79 -September 80 membership year include: public ombudsman program for computer grievance; switched network, personal computing network; a computer fair at a local mall; *ASCII Code* to move from 6 to 12 issues annually; several programming schools; public access center; and a television program (in production!).

Zips 70000-80000

1. **The Tulsa Computer Society**
2. POB 1133, Tulsa OK 74101
3. Tulsa Vocational-Technical School 3420 S Memorial Dr
4. Last Tuesday of the month at 7:30 PM
5. *The I/O Port*
8. $6 per year

1. **The Computer Hobbyist Group of North Texas**
2. 2405 Briarwood, Carrollton TX 76006
5. *Printed Circuit*
6. Warren Bean
8. $7 per year

1. **Alamo Computer Enthusiasts**
2. 5411 Cerro Vista, San Antonio TX 78233
3. Norris Technical Center, Room 208, St Philip's College, San Antonio TX
4. Third Friday of the month
5. Yes
6. Dave Fashenpour

1. **North American Computer Association**
2. Suite 811, 1001 Main St, Lubbock TX 79401
3. Dallas TX
4. Second Friday of each month
6. Tom Crites
7. (806) 747-4119
8. $200
9. Independent computer representatives. Must sell,

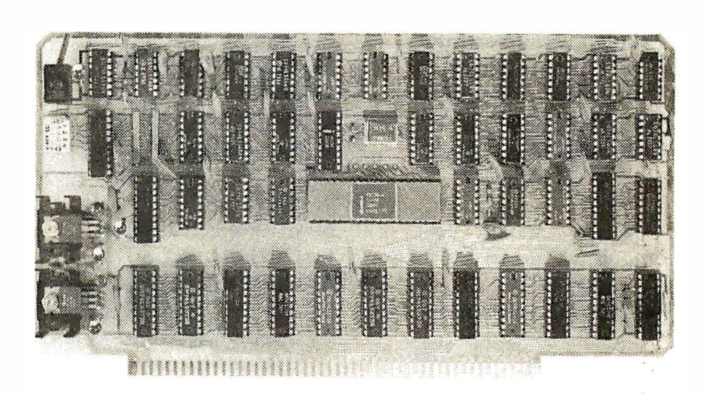
Now! For the S-100 bus

8086 Power

WITH 16-BIT WORD LENGTH

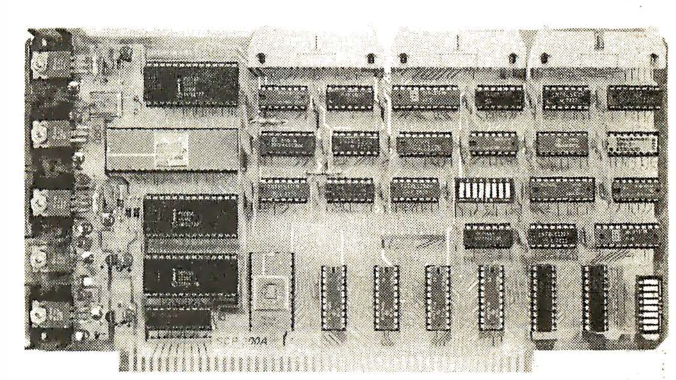
8086 CPU

This card brings state-of-the-art performance to the S-100 bus. It may be used to upgrade existing 8-bit systems by "swapping" the CPUs or it may form the foundation for a high performance 16-bit system. It will operate with 8-bit, 16-bit, or mixed memory and peripherals. It has a 1-megabyte addressing range. It can be factory upgraded at nominal cost from 4 Mhz. to 8 Mhz. when the faster CPU chip is available. Price — $895.



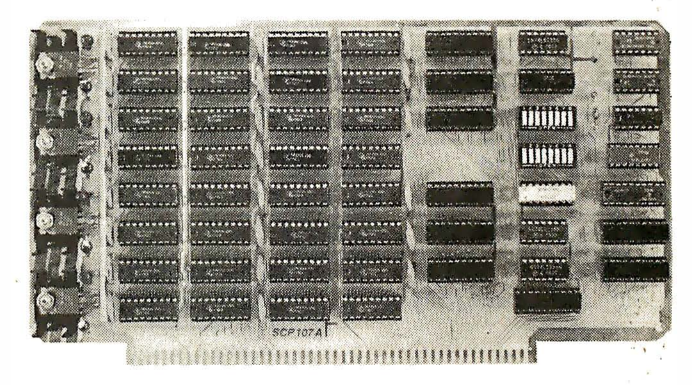
CPU Support Card

This is a companion to our 8086 CPU. It includes a 2K monitor with machine language debugger and disk bootstrap loader, serial port with software-selected baud rate, time-of-day clock with battery backup capability, two general purpose timers/counters, and a vectored interrupt controller with 7 interrupts generated on board and 8 accepted from the bus. Price — $395.



8/16 Memory Card

Through the use of the sXTRQ line of the proposed IEEE Standard, this memory board will appear to be 8K by 16 bits to our 8086 CPU or 16K by 8 bits to 8-bit CPUs. It is offered with 250 nsec. memory chips only and will perform without wait states with our 8086 CPU using an 8 Mhz. clock. It has 24-bit extended addressing. Price — $595.



(Prototypes shown)

Z80/8086 Cross Assembler

This cross assembler runs under CP/M and its derivatives. Its mnemonics are the same as or similar to Intel's ASM-86. It is available in 5" soft-sectored, 5" North Star, or 8" soft-sectored (IBM) formats. Price — $250.

Microsoft BASIC-86

Microsoft's BASIC interpreter for the 8086 is essentially identical in features to their 5.0 release for the 8080 and is ANSI compatible. It is a "stand-alone" version and includes all disk and terminal I/O drivers. Programs written for any earlier version of Microsoft BASIC will run under BASIC-86 with little or no modification. Price — $350.

MCS-86 User's Manual

By Intel — Feb., 1979, edition. This is the primary hardware and software reference manual for the 8086 CPU. Price — $6.25. (Includes shipping)

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(206) 575-1830

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program, and service business systems.

1. **Permian Basin Computer Group**
2. c/o Ector School District, POB 3912, Odessa TX 79760
3. Midland Chapter: Student Union Building, Midland College. Odessa Chapter: Electronic Technology Building, Room 209, Odessa College.
4. Midland Chapter: monthly, the second Tuesday, 7:30 PM. Odessa Chapter: monthly, the second Saturday, 1 PM
5. None
6. John Rabenaldt
7. (915) 697-4607 (after 6 PM), (915) 332-9151 Ext 43 (9 AM to 5 PM)
8. No dues
9. Selectric interfaces, color displays, and MECA tape.
10. The Permian Basin Computer Group consists of 2 chapters.

1. **TRS Users - Permian Basin Group**
2. Rt #4, POB 1455, Odessa TX 79763
3. Rm 209, Electronics Technology Building, Odessa College
4. Second Saturday of the month at 1 PM
5. None
6. Allan D Emert
7. (915) 381-3138
8. None
9. Information and software exchange.

Zips 80000-90000

1. **Denver Amateur Computer Society**
2. 1380 S Santa Fe, Denver CO 80223
3. Same
4. Third Wednesday of every month. General board meeting - first Wednesday of every month.
5. *Interrupt*
6. Carl Grimes
7. (303) 759-8969
8. $12 per year membership fee
9. Pascal, 6502, Z80/8080, CP/M, and TRS-80.
10. Annual Computer Show, called the "Computer Corral," at the Denver Merchandise Mart October 27th and 28th.

1. **Southern Nevada Personal Computing Society**
2. 1405 Lucilee St, Las Vegas NV 89101
3. Society Headquarters, 1405 Lucilee St
4. Second Saturday of each month at 12 noon
5. *Hard Copy* (monthly)
6. Cy Wells, President
7. (702) 642-0212
8. Corporate: $12 per year; family: $18 per year; corresponding: $6 per year; student: $3 per year
9. Both hardware and software; exchange of information and experience; and guidance and encouragement for the new hobbyist.

1. **Northern Nevada Computer Club**
2. c/o Mathematics Dept University of Nevada, Reno NV 89557
3. University of Nevada
4. (TBA)
5. *Meeting Announcements*
6. Professor Al Brady
7. (702) 784-6831
8. None
9. Personal computing and educational computing.

Zips 90000-99999

1. **San Fernando Valley 6502 Users Club**
2. 3816 Albright Ave, Los Angeles CA 90066
3. Computer Components Inc of Burbank, 3808 W Verdugo Rd, Burbank CA 91505
4. Second Tuesday of every month at 8 PM
5. *SFV 6502 Users Club Notes*
6. Larry Goga
7. (213) 398-6086
8. None at this time
10. The club is open to all owners of 6502-based computers including KIM, SYM, and AIM. PET and APPLE owners are also welcome. Formerly known as the San Fernando Valley KIM-1 Users Club.

1. **Compucolor and Intecolor Users Group**
2. 5250 Van Nuys Blvd, Van Nuys CA 91401
3. Same as above.
4. First Saturday of each month from 12 to 3 PM
5. *Users Bulletin* (quarterly)
6. Stan Pro
7. (213) 788-8850 10 to 6 PM weekly
8. $25 per year; foreign add $8
9. Business; games and graphic programs exchange; unpublished ports; poke positions and machine data; addition of peripherals to Compucolor and Intecolor; and machine updates.
10. International in scope.

1. **Ventura County TRS-80 Club**
2. 567 W Loop Dr, Camarillo CA 93030
3. Camarillo Public Library, 3100 Ponderosa Dr, Camarillo
4. First Tuesday of the month at 7 PM
5. Yes
6. Lee Steinmetz
7. (805) 484-1724
8. $10 per year
9. The group's main purpose is to share information relating to the practical applications as well as the entertainment possibilities of the TRS-80.

1. **Homebrew Computer Club**
2. POB 626, Mountain View CA 94040
3. Fairchild Auditorium, Stanford Medical Center
4. Meeting dates are published in the club newsletter
5. *Homebrew Computer Club Newsletter*
6. Robert Reiling, President
7. (415) 967-6754
8. Donation requested
9. Information exhange on all systems and providing "vectors" to people and groups with similar interests.
10. A newsletter copy will be sent upon request, include a self-addressed stamped envelope. Anyone interested in computers is invited to attend Homebrew Computer Club meetings.

1. **Apple Core**
2. POB 4816, San Francisco CA 94101
3. Homestead Savings, 22nd and Geary St, San Francisco
4. First Saturday of each month at 10 AM
5. *Cider Press*
6. Ken Silverman
7. (415) 878-5382
8. $15 per year
9. Apple owners only.

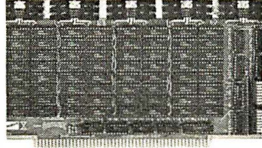
1. **Pacifica TRS-80 Users Group**
2. 637 Brussels St, San Francisco CA 94134
3. Eureka Square Shopping Center
4. Second and Fourth Thursdays of the month
6. John F Strazzarino

1. **Solano TRS-80 Users Club**
2. 550 Marigold Dr, Fairfield CA 94533
3. Owens-Illinois, 2500 Huntington Dr, Fairfield CA
4. Third Thursday of the month
6. Steve Irwin
7. (707) 422-3347
9. Informal group that gets together to discuss mutual TRS-80 problems and experiences.

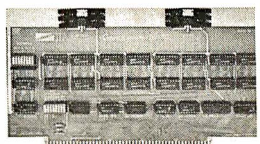
1. **ABACUS (Apple Bay Area Computer Users Society)**
2. Hayward BYTE Shop, 1122 B St, Hayward CA 94541
3. Same as above
4. Second Monday of the month
5. Yes
6. Ed Avelar, President
7. (415) 583-2431
10. Have an active membership of 40, and have developed a club library of 200-plus programs.

1. **RETUG (Redwood Empire TRS-80 Users Group)**
2. 7136 Belita Ave, Rohnert Pk CA 94928
3. Santa Rosa Computer Center
4. First Saturday of each month
6. John Revelle
7. (707) 545-2860
9. TRS-80s.

We Specialize in High Technology at Low Prices.



Econoram* boards are generally available in 3 forms: **unkit** (sockets and bypass caps are **pre-soldered** in place for simple, one-evening assembly), **assembled and tested**, or qualified under our high-reliability **Certified System Component (CSC)** program (200 hour burn-in, immediate replacement in event of failure within 1 year of invoice date). 1 year limited warranty on all products. Refer to chart below for pricing.



Name	Storage	Buss	Configurations	Notes	Unkit	Assm	CSC
Econoram IIA	8K X 8	S-100	2-4K blocks	1	**$149**	**$179**	**$239**
Econroam IV	16K X 8	S-100	1-16K	1	**$269**	**$329**	**$429**
Econoram VIIA-16	16K X 8	S-100	2-4K, 1-8K	1	**$279**	**$339**	**$439**
Econoram VIIA-24	24K X 8	S-100	2-4K, 2-8K	1	**$398**	**$485**	**$605**
Econoram IX-16	16K X 8	Dig Grp	2-4K, 1-8K	1	**$319**	**$379**	n/a
Econoram IX-32	32K X 8	Dig Grp	2-4K, 1-8K, 1-16K	1	**$559**	**$639**	n/a
Econoram X	32K X 8	S-100	2-8K, 1-16K	1	**$529**	**$649**	**$789**
Econoram XI	32K X 8	SBC/BLC	2-8K, 1-16K	1	n/a	n/a	**$1050**
Econoram XII-16	16K X 8	S-100	see notes	1, 2	**$329**	**$419**	**$519**
Econoram XII-24	24K X 8	S-100	see notes	1, 2	**$429**	**$539**	**$649**
Econoram XIII	32K X 8	S-100	see notes	1, 3	**$559**	**$699**	**$849**
Econoram XIV	16K X 8	S-100	see notes	1, 4, 5	**$289**	**$349**	**$449**
Econoram XV-16	16K X 8	H8	1-16K	1, 6	**$329**	**$395**	n/a
Econoram XV-32	32K X 8	H8	2-16K	1, 6	**$599**	**$729**	n/a

Notes:
1. Works at 5 MHz with 8085 or at 4 MHz with Z-80.
2. Bank select board — 2 independent banks addressable on 8K boundaries.
3. Bank select board — 2 independent banks addressable on 16K boundaries.
4. Bank select board — 1 bank addressable on 4K boundaries.
5. 24 address lines for extended addressing.
6. Bank select option for implementing memory systems greater than 64K.

***Econoram** is a trademark of **Bill Godbout Electronics.**

Coming soon: This month, we're announcing the **Econoram XIV** with extended addressing, two new **Econorams (XV-16 and XV-32)** for the H8 buss, and our **Memory Management Board.** In the next few months, we'll be introducing...

- 4 MHz Z-80 CPU board
- 5 MHz 8085 CPU board
- Triple Parallel + Single Serial board, with 3 full duplex parallel ports and serial port with full RS-232 handshake
- 12 and 18 slot motherboards — double sided, shielded, and actively terminated
- And, a rack mount or desk top enclosure, with power supply, to hold all this neat stuff

Just thought you ought to know.

16K Memory Expansion Chip Set $87.20 (regular $109; 20% off while they last)

This Godbout quality product expands memory in **Radio Shack-80, Apple,** and **Exidy Sorcerer** computers. Our chip set features low power, high speed (250 ns) parts that work with 4 MHz systems. DIP shunts included. Easy-to-follow instructions for Radio Shack-80 modification make conversion simple. 1 year limited warranty.

"INTERFACER" S-100 I/O Bd $189 unkit, $249 assm

Dual serial port with 2 full duplex parallel ports for RS-232 handshake; EIA232C line drivers and receivers (1488, 1489) along with current loop (20 mA) and TTL signals on both ports. Onboard crystal-controlled timebase with independently selectable Baud rate generators for each part (up to 19.2 KBaud). This board has hardware LSI UARTs that don't tie up the computer's CPU, operates with 2 to 5 MHz systems, includes software programmable UART parameters/interrupt enables/handshaking lines, offers provision for custom frequency compensation on both receive and transmit sides to accommodate varying speed/noise situations or unusual cable lengths...and even all this isn't the full story on what this no-excuses board can do for you.

Econoram II Closeout $129 unkit (3/$375), $155 assm

This is a limited quantity item. Our brand new **Econoram IIA** is out, but even by today's standards the original **Econoram II** is an excellent memory. 2 MHz operation, low power, configured as two independent 4K blocks, and one of the best track records in the industry for reliability and cost-effective operation. Easy one-evening assembly, 1 year limited warranty on all components.

18 Slot Motherbd Closeout — was $124, now only $109

Includes on-board active termination, with all 18 edge connectors pre-soldered in place for easy assembly. Limited quantity.

Memory Management $59 kit, $85 assm, $100 CSC

Now you can add bank select and extended addressing to older S-100 machines like the **IMSAI, Altair, Sol, Polymorphic,** etc. Either use this board with our new extended addressing boards, or retrofit our high density **Econorams** (the ones with phantom or extra qualifier lines) for use with the **Memory Management Board** to get more than 64K of memory space for your computer.

2708 EROM board unkit $85

4 independently addressable 4K blocks, with selective disable for each block. Built to **CompuPro/Econoram** standards (dipswitch addressing, top quality board, sockets wave-soldered in place), and includes dipswitch selectable jump start built right into the board. Includes all support chips and manual, but does not include EROMs.

ACTIVE TERMINATOR kit $34.50

Our much imitated design plugs into any S-100 motherboard to reduce ringing, noise, crosstalk, and other buss-related problems. This is a simple, effective, low cost way to upgrade your machine.

SEE COMPUPRO™ AT A STORE NEAR YOU.



Many Godbout computer products are available under the CompuPro name at leading computer stores world-wide. Want to see for yourself exactly what kind of quality and effort we put into turning out cost-effective, high performance boards? Then see our products in person at a computer store near you.



TERMS: Cal res add tax. Allow 5% for shipping, excess refunded. VISA®/Mastercharge® call our 24 hour order desk at (415) 562-0636. COD OK with street address for UPS. Prices good through cover month of magazine.



Bldg. 725, Oakland Airport, CA 94614

from



FREE FLYER: We'll be glad to tell you more than the space of this ad permits. Just send your name and address, we'll take care of the rest. If you're in a hurry, enclose 41¢ in stamps for 1st class delivery.

1. **68XX(X) Computer Club**
2. POB 18081, San Jose CA 95158
3. University of Santa Clara
4. Second Tuesday of each month
5. None
6. Ray Boaz
7. (408) 269-9522
8. None
9. All 68XX(X) microcomputers and related equipment. Latest developments in hardware and software for 68XX(X). Further the use of 68XX(X) computers in personal applications. Mutual aid in hardware and software problems.
10. Meetings are for the informal exchange of information. A software library is maintained for the common use of all.

1. **Sacramento Microcomputer Users Group**
2. POB 161513, Sacramento CA 95816
3. SMUD Training Facilities, 59th St
4. Fourth Tuesday of the month at 7:30 PM
5. *Push & Pop*

1. **Aloha Computer Club**
2. POB 4470, Honolulu HI 96813
3. Kaimuki Regional Library (usually)
4. Usually the second Wednesday of the month at 7:30 PM
5. *Debugga* (monthly)
6. Paul Lancaster or Gerry Cramm
7. (808) 235-3880 or (808) 254-2319, respectively
8. $6 per year
9. Anything goes, as long as it is microcomputers.
10. Our users group meeting is followed by a short business meeting after which is a special presentation, then "mapping" and "random access."

1. **Apple Portland Program Library Exchange (A.P.P.L.E.)**
2. c/o Will Newman II, Secretary/Treasurer, 1915 N E Couch, Portland OR 97232
3. Varies
5. *Stems From A.P.P.L.E.*
6. Will Newman II
7. (503) 233-5711 (days and evenings)
8. $2 application (one time) $6 per year membership includes subscription (12 issues a year)
9. Wide variety of professional and hobby users. We trade programs and programming techniques and hold training classes (beginning to advanced) with local retailers.
10. Inquiries must be accompanied by a self-addressed, stamped envelope.

1. **Northwest Computer Society**
2. POB 4193, Seattle WA 98104
3. Seattle University Library Auditorium, Rm 115
4. First and third Thursdays of each month at 7:30 PM
5. *Northwest Computer News*
6. Roy Gillette, President, John Aurelius, Secretary
8. $7 January thru December; $10 June thru the 2nd December
9. Beginners, business, and hobbyists. Special sections: Tacoma chapter, TRS-80 group, and Heath H-8 group.
10. First meeting each month is formal with a speaker; the second meeting is informal.

1. **Apple Pugetsound Program Library Exchange**
2. 8710 Salty Dr NW, Olympia WA 98502
3. Rotates through various computer stores in the Seattle/Tacoma area
4. Third Tuesday of every month
5. *Call - A.P.P.L.E.*
6. Val Golding
7. (206) 932-6588
8. $10 for 1979.

Newsletters

Zips 00000-10000

1. **Harvard Newsletter on Computer Graphics**
2. Harvard University

Laboratory for Computer Graphics, 520 Gund Hall, Cambridge MA 02138
6. William Nisen
8. $125 per year; $45 for 9 issues
10. The newsletter monitors important commercial, technological, and product developments, as well as market, application and learning opportunities.

1. **Sorcerer Users Group**
2. 1395 Main St, Waltham MA 02154
3. None as of yet
5. The *Exidy Monitor*
6. Bruce R McGlothlin
7. (617) 899-4540
8. $10 per year
9. The main purposes of the group are to make hardware and software developments known and available to the Sorcerer user, to supply software to the user, and to initiate an information service.

1. **Computers in Psychiatry/Psychology**
2. 26 Trumbull St, New Haven CT 06511
5. *Computers in Psychiatry/Psychology* (formerly *Micro-Psych*)
6. Marc Schwartz MD
7. (203) 562-9873
8. $15 per year for membership and 6 issues of the 13-page newsletter
9. Clinical, research and interesting mental health uses of computers, office management, and administration. The newsletter contains articles, reviews, ongoing bibliography, psychology program catalog, training opportunities, job openings, and news of members' activities. Now publishing Vol. 2 of newsletter. Vol. 1 available for $12.

1. **Physicians Microcomputer Report**
2. POB 6483
3. Lawrenceville NJ 08648
6. Dr Gerald M Orosz
8. $25 per year; $12.50 for students
9. Monthly publication for doctors who wish to become better informed about the computer and its application in the field of medicine.

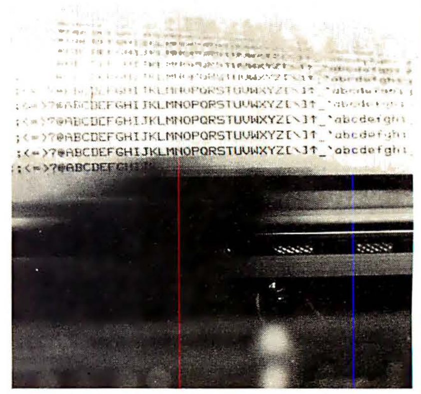
Zips 10000-30000

1. **Digital Group Independent Users Group**
2. POB 316, Woodmere NY 11598
5. *BRIDGE* (Bi-directional Reflections for the Illumination of Digital Group Enthusiasts)
6. Lloyd Kishinsky
8. $10 for 10 issues of newsletter
9. A newsletter devoted to helping digital group users over the voids.
10. Newsletter published every 6 weeks. Vol. III starting in Fall '79. Newsletter includes helpful hints from users, items for sale, software exchange, applications, hardware and software fixes, Phideck special interest group, and articles submitted by members. Membership is approximately 350.

1. **BUSS**
2. 325 Pennsylvania Ave SE, Washington DC 20003
5. *Buss: The Independent Newsletter of Heath Company Computers*
6. Charles Floto
7. (202) 544-0484
8. $8.50 for 12 issues
9. Software and hardware compatible with computers made by the Heath Company.
10. Sample issue availabe upon request mentioning BYTE.

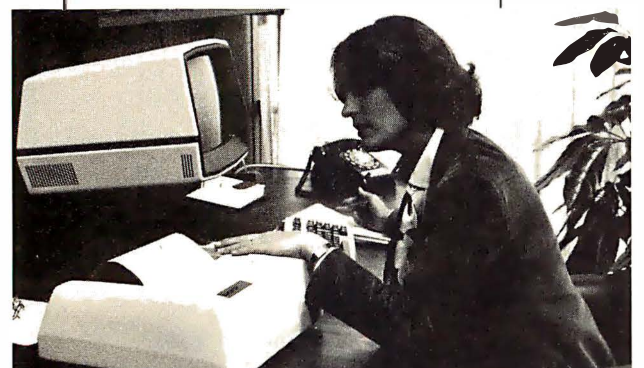
1. **ARESCO**
2. POB 1142, Columbia MD 21044
5. Four newsletters: *The Paper, VIPER, RAINBOW,* and *The Source.*
6. Rick Simpson or Terry Laudereau
7. (301) 730-5186
8. $15 for 10 issues
9. *The Paper* - for owners of the Commodore PET. *The VIPER* - for owners

The Comprint 912 printer. No one else can match our speed, our print quality, our quiet operation, or our reliability. Not for $660 they can't.



The Comprint 912 prints nearly 3 lines every second.

Our Comprint 912 is the best printer for the money. Period. Any printer that can match our price can't even begin to match our performance. And any printer that boasts performance like ours doesn't even come close to our price. No matter what your application; computer reports, listings, CRT hard copy, message receiving, scientific/industrial data logging, or anything you can think of, the Comprint 912 is **the** performance leader in printers under $1000.



CRT hardcopy is an excellent application for the Comprint 912.

First consider our performance.

Speed. At 225 characters per second (170 LPM) the Comprint 912 is up to 4 times faster than impact printers costing hundreds of dollars more. With our printer you don't waste time and money waiting for your print-out.

Print Quality. Our 9x12 matrix provides sharp, crisp characters. Compare that with our competition. Their very best is a 9x7 matrix, which means no lower case descenders and cramped letters. With the Comprint 912 you don't have to put up with the irritation of fuzzy, hard to read computer printing. This

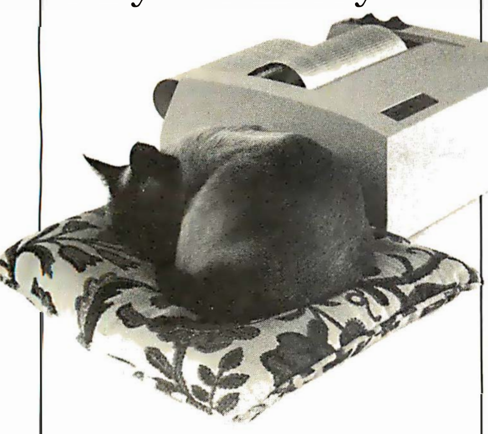
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xceptional print quality in
ly by the Comprint 912 in 7
nless reliability, 6 month
rallel I/O and 8 1/2" wide
been shipped to happy custc
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The superior print quality provided by the Comprint 912 is obvious in this actual size sample.

means increased productivity. And because the Comprint 912 makes better originals, our originals make better Xeroxes.

Quiet Operation.

Most computer printers are irritatingly noisy. They can disrupt concentration and reduce the efficiency of anyone working near them. They're noisy because they're

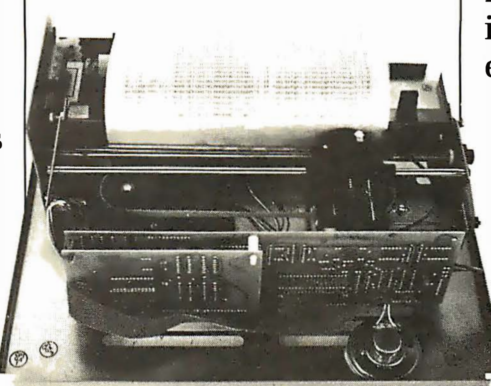


The Comprint 912 is quiet because it's electronic not mechanical.

impact. The Comprint 912 has no mechanical print head banging on the paper. It's electronic. It's quiet.

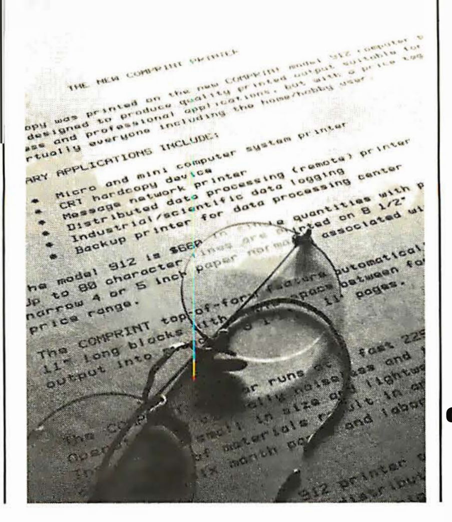
Reliability.

Since the Comprint 912 prints electronically, rather than mechanically like ordinary impact printers, we have fewer moving parts and less vibration. The Comprint 912 has fewer things to go wrong and less wear. That's why we offer a 6 month warranty, twice the industry standard. The key to all this superior performance is our special



Fewer moving parts in the Comprint 912 mean greater reliability.

paper. This aluminized "silver paper" works just like ordinary paper. It won't fade or discolor and actually costs less than plain paper and one time ribbons. For the vast majority of printing applications it's just plain better than plain paper. Especially when you consider the hidden costs of plain paper printers due to their inferior performance compared to the Comprint 912. And on those rare occasions when you really do



need a plain bond paper copy, just run your Comprint 912 printout through your plain bond copy machine and you've got it. Even though our paper is special, it's available everywhere; from your dealer or distributor, or from us.

Now consider our price.

The Comprint 912.

$660 with parallel interface, $699 with serial interface.

We could talk about our other advantages, like our 80-character lines on 8-1/2" wide paper, or our compact, light-weight size, and the fact that the Comprint 912 has no ribbons to mess with, no chemicals, nothing to add but paper.

But you have to see for yourself. Before you buy any printer, insist on seeing the Comprint 912, **the** performance leader, at your local computer store or industrial distributor. Or contact us for a descriptive brochure, a sample print-out, and applications literature.

comprint

The performance leader.

Computer Printers International, Inc.
340 E. Middlefield Rd.
Mountain View, California 94043
415 969-6161

Circle 52 on inquiry card.

of the RCA VIP. *Rainbow* - for owners of the APPLE II. *The Source* - for owners of the Exidy Sorcerer.
10. A subscription is for all 10 issues of one volume. Back issues are sent automatically.

1. **Microcomputer Investors Association**
2. 902 Anderson Dr, Fredericksburg VA 22401
3. As called
4. As called
5. *The Microcomputer Investor*
6. J Williams
7. (703) 371-5474
8. $30 per year
9. An association of persons who utilize microcomputers to assist in making and managing investments.
10. Each participating member is required to publish one article per year in *The Microcomputer Investor*.

1. **TRS-80 Users Group**
2. 7554 Southgate Rd, Fayetteville NC 28304
5. *TRS-80 Users Group Newsletter*
6. Mr Robert G Lloyd
7. (919) 867-5822
8. $15 per year
9. To exchange programs with the members of the group at no cost.
10. We are an international group with over 1500 members from more than 20 countries.

1. **TIPS Newsletter**
2. 101 Brookbend Cr, Mauldin SC 29662
5. *TIPS Newsletter*
6. Fred Holmes
7. (803) 288-5664
8. $3 for 4 issues
9. Support all microprocessor products produced by National Semiconductor from a hobbyist point of view, plus related semiconductor products from other companies. Microprocessors supported include IMP-16, SC/MP and INS 8070. Complete construction plans for microprocessor systems including I/O (input/output) devices such as 24 by 80 video display, digital cassette and floppy disk. Also, system support software published.
10. Complimentary issue sent for a self-addressed stamped envelope.

Zips 30000-80000

1. **6502 User Notes**
2. POB 33093, N Royalton OH 44133
5. Yes
6. Eric C Rehnke, Publisher
7. (216) 237-0755
8. $13 for Volume 3 in N America, $19 for Volume 3 elsewhere.
9. The newsletter supports KIM, SYM, AIM, and OSI 6502-based machines. We have special sections dealing with BASIC, Forth, FOCAL, Tiny BASIC, KIMSI, interface, music, etc.

1. **The International Institute for Robotics**
2. POB 615, Pelahatchie MS 39145
5. *Robotics Newsletter*
7. (601) 854-5339
8. $8 for 12 issues
10. The newsletter solicits articles on all facets of robotics; we pay $15 to $50 per page for accepted articles. The Institute also offers free parts to hobbyists for articles; this is in addition to the payment above. The Institute also makes available a basic and an advanced course in robotics..

1. **SR-52 Users Club (International)**
2. 9459 Taylorsville Rd, Dayton OH 45424
3. No meetings
5. *52-NOTES*
6. Richard C Vanderburgh
7. (513) 233-3698
8. $1 per issue of *52-NOTES* ($1.67 abroad, excluding Canada and Mexico).
10. Back issues are available at the same rates, beginning June 1976, monthly through February 1979. Texas Instruments-58/59

coverage began June 1977.

1. **The Target-an Aim 65 Newsletter**
2. RR#2, Spencerville OH 45887
5. *The Target-an Aim 65 Newsletter*
6. Donald Clem
7. (419) 647-6576
8. $5 in US and Canada, $12 elsewhere
9. The newsletter is for present and future Rockwell Aim 65 users. The Aim is built around the 6502 microprocessor, so the information is useful for all 6502s. The newsletter contains software and hardware usable with the Aim.
10. The newsletter is published bimonthly. Six issues a year per subscription. Past issues have contained articles on the printer, the display, power supplies, product reviews, as well as other information.

1. **Apple Library**
2. 51625 Chestnut Rd, Granger IN 46530
3. Mail only
5. No
6. Joe Torzewski
7. (219) 272-4670
8. None
9. Support of Apple computer.
10. Send self-addressed stamped envelope, please.

1. **Mid-Michigan Computer Club**
2. 9274 Marinus Dr, Fenton MI 48430
3. No scheduled meetings
5. None
6. Tony Preston
7. (313) 629-0363
8. None
9. Games, artificial intelligence, and operating systems.

1. **The Target**
2. Custom - Tronics, POB 4310, Flint MI 48504
8. $15 per year
10. Bimonthly newsletter for owners or prospective owners of Aim 65 systems.

1. **SCAMPUS (SC/MP Users Society)**
2. POB 132, Knob Noster MO 65336
3. None
4. None
5. *SCAMPUS Newsletter*
6. Tom Bohon, Coordinator
7. (816) 563-2650
8. $2 per year plus large, self-addressed stamped envelopes for newsletter mailings
9. Composed of members who are interested in or actually building systems based on the National Semiconductor SC/MP-II processor.
10. All members have access to a growing library of both articles and programs for cost of reproduction and postage. The newsletter is approximately monthly. Current newsletter is available to interested parties for large, self-addressed stamped envelope. Group is trying to design a project computer for interested members to build.

1. **Theater Computer Users Group**
2. 104 N St Mary, Dallas TX 75214
3. None, a national group for exchange of information.
4. Newsletter, 4 times a year.
5. *TCUG NOTES* about 4 times a year
6. Mike Firth
7. (214) 827-7734 days or evenings.
8. $4 to cover costs of 4 issues of the newsletter (about a year).
9. The uses of computers in live drama (theater) operations such as light control, administration, design, and sales.

Zips 80000-90000

1. **COSMAC Users Group (CUG)**
2. POB 7162, Los Angeles CA 90022
3. Local chapters may be formed in the future
5. *The 1802 Peripheral*
6. Patrick Kelly, Director
7. Inquiries to above address; please include self-

addressed stamped envelope.
8. Membership is free; subscription to newsletter is $5 for 12 issues (minimum 8 pages, each). All subscriptions must start with Volume #1, Issue #1.
9. The CUG is a user's group for all 1802-based microcomputers, including Basic ELF, ELF-II, Super-ELF, UC-1800, DSD-1802, VIP, homebrews, etc.
10. The CUG is a nonprofit, national syndicate of 1802-based computer owners and users. Our members provide copies of their own software and hardware to other CUG members, charging only for actual copying and postage costs. Each member receives a detailed listing in our newsletter, which publishes both software and hardware articles and reviews.

1. **Poly 88 Users Group**
2. 1477 Barrington #17, Los Angeles CA 90025
3. None
5. *Poly 88/Poly 8813 Users Group Newsletter*
6. Pat or Roger Lewis
7. (213) 477-8478 after noon
8. $5 US and $15 foreign for 12 issues
9. Software exchange or hardware tips.
10. $2.50 for programs without trade. $2 for cassette. $3 for disks.

1. **Business Computing Press**
2. POB 55056, Valencia CA 91355
5. *Business Computing Newsletter*
6. Alan Bartholomew, Publisher, Greg Scott, Editor
7. (805) 255-8543 or (213) 881-8076 respectively
8. Newsletter - available free at computer stores.

1. **Computer Information Exchange**
2. POB 158, San Luis Rey CA 92068
3. None
5. *TRS-80 Bulletin*, *TRS-80 Computing*
6. Bill McLaughlin, Editor
7. (714) 757-4849
8. Bulletin free, *TRS-80 Computing* 2 for $15
9. TRS-80 uses.

1. **PROTEUS, The Processor Technology Users Society**
2. 1690 Woodside Rd, Suite 219, Redwood City CA 94061
3. Various chapters throughout USA and Canada
5. *PROTEUS/News* (bimonthly, equivalent to 48 pages per issue)
6. Stan Sokolow
7. (415) 368-3331
8. $12 in USA, $15 in Canada or Mexico, $20 elsewhere (US funds only, please)
9. A balance between hobbyist and commercial interests: tutorial articles, hardware reviews, software reviews, news, group discounts, program library, tape recorded lectures, and communication among members.
10. Formerly known as Solus, we are now open to anyone owning a Sol, CUTS, or Helios, or any compatible hardware. Send $2 for a sample issue of the newsletter.

1. **Cromemco User Systems and Software Pool (CUssP)**
2. POB 784, Palo Alto CA 94302
4. Locally arranged
5. *CUssP Newsletter*
6. David Dameron
7. (415) 321-5998
8. $10 for 3 issues; $12 outside USA, Canada and Mexico
9. Users of Cromemco computers and boards.
10. The purpose of CUssP is the exchange among users of operating notes, hardware and software modifications, user written software, evaluations, and Cromemco announcements.

1. **LISP Users Newsletter**
2. 18215 Bayview Dr, Los Gatos CA 95030
6. John R Allen
9. This newsletter is designed to spread information about applications, implementation and general

information on LISP-like languages.

1. **Quest Electronics**
2. 2322 Walsh Ave, Santa Clara CA 95051
5. *Questdata*
6. William Haslacher
7. (408) 988-1640
8. $12 per year
9. Monthly newsletter for 1802 microprocessor users.

1. **HEX Users Group**
2. 36012 Military Rd S, Auburn WA 98002
3. None
4. None
5. Irregular, 3 to 4 issues per year.
6. Charles C Worstell
7. (206) 927-6038
8. $4
9. Devoted to systems without American Standard Code for Information Interchange (ASCII) keyboard (mostly 6800 D2)

1. **80-Northwest Publishing Co**
2. POB 7112, Tacoma WA 98407
5. *The 80-US Journal* (bimonthly)
6. Mike Schmidt, Editor
7. (206) 759-9642
8. $16 per year (US)
9. The *Journal* is devoted entirely to the TRS-80 microcomputer system. It covers all aspects including business, scientific, educational, tutorials, hardware and games.
10. In less than 1 year, the *Journal* has gone international. It also pioneered the use of animated graphics with sound on the TRS-80. It gave birth to ANDY (Android Nim) and others, and introduced advanced "string packing" techniques.

Foreign Clubs and Newsletters

1. **MICOM (The Microcomputer Club of Melbourne)**
2. MICOM, POB 60, Cantebury, Victoria 3126 AUSTRALIA
3. AMRA Hall, Wills St, Glen Iris
4. Third Saturday of the month.
5. Newsletter (monthly); magazine (quarterly).
6. Andrew Stewart, Secretary
7. (03) 277-1613
8. $7.50 per year
9. None; we try to interest all microcomputer enthusiasts.
10. Membership: 120-plus.

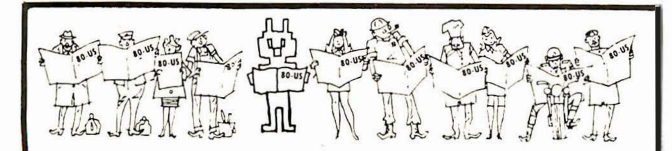
1. **Australian 9900 Users Group**
2. GPO Box 835, Melbourne, Victoria 3001 AUSTRALIA
3. None - correspondence only
5. None - direct contact
6. Barry Day
7. (03) 661-2523
8. None
9. Anything and everything to do with the 9900 or associated devices.
10. We are by necessity a correspondence group and are now in touch with groups in the USA and the United Kingdom. We will always answer all correspondence promptly and would be glad to make new contacts in both hardware and software fields.

1. **COM-3**
2. POB 268, Niddrie, Victoria 3042 AUSTRALIA
5. *COM-3*
6. Timothy Mowchanuk, Editor
7. Work (03) 336-1855 Home (03) 379-6812
8. $10 (in Australia), $15 (Foreign - surface mail), $25 (Foreign - airmail). All checks in Australian dollars. Make check payable to: C.E.G.V.
9. Educational uses of computers.

1. **Brazilian Microcomputer Club, and TRS-80 Users Group**
2. Attention: Douglas Gilson, Rua Sambaiba, No. 516, Leblon, Rio de Janeiro BRAZIL
3. Same as above
4. Weekly
5. None
6. Douglas Gilson

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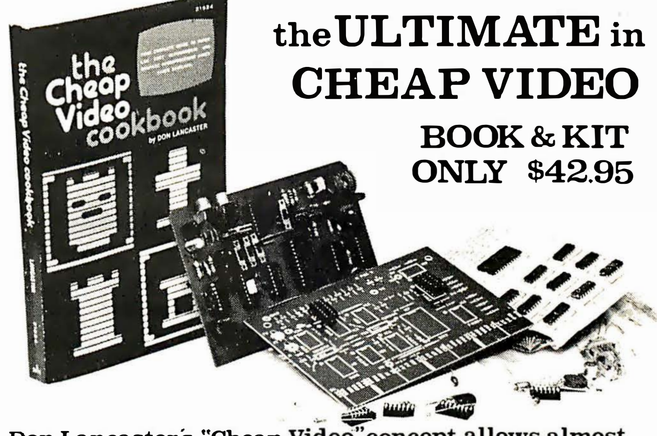
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7. 274-0308, 274-2439
8. None
9. We receive manufacturer's news, software publisher's news, exchange programs, and exchange ideas.
10. Most of our club's members have the TRS-80, but we are open to anyone who has a microcomputer.

1. **The Ottawa Computer Group**
2. POB 13218, Kanata, Ontario, CANADA K2K-1X4
3. National Research Council, Sussex Dr, Ottawa
4. General meeting second Monday of each month
5. *OCG Newsletter*
6. Don Sharkey, President
7. (613) 824-0909, (613) 992-6858
8. $10 (Canadian) for first full year $5 (Canadian) for renewals
9. Active local user groups for most popular systems and processors. We have a locally designed and produced central processor board and expansion boards - The Mimic System. There also is an active Mimic users group.
10. Currently we are cooperating with the National Museum of Science and Technology in establishing a computer display. Weekly seminars or discussions are held for specific areas such as hardware, software and technical topics. Membership is approaching 250, monthly meetings are attended by an average of 110 members and guests.

1. **Association of Computer Experimentors (ACE)**
2. 102 McCrany St, Oakville, Ontario, CANADA L6H 1H6
3. Hamilton, Ontario
4. Monthly (September to May)
5. *IPSO FACTO*
6. Bernie Murphy
8. $15 per year in Canada; $18 per year elsewhere
9. Microcomputers based on the 1802 microprocessor. Our members have various types of machines (ELF, VIP, Tektron, etc), and are involved in both hardware and software experimentation.

1. **Toronto Region Association of Computer Enthusiasts**
2. POB 6922, Postal Station A, Toronto, Ontario CANADA M5W 1X6
3. Ontario Science Centre and Humber College
4. Meetings are every second Sunday of month at 2 PM in the Ontario Science Centre and every fourth Friday at 7:30 PM at Humber College
5. *TRACE*
6. Ross Cooling
7. (416) 488-3314
8. $13

1. **Vancouver PET Users Group**
2. POB 35353 Station E, Vancouver, BC CANADA
3. 404 East 51st Ave (Sunset Community Center)
5. *Vancouver PET News*
6. Niels Hansen-Trip
7. (604) 274-2064
8. $20 per year including newsletter. Nonmember newsletter is $1 per issue.
9. Support for the Commodore PET 2001 computer and every other conceivable computer device.
10. Meetings consist of presentations, demonstrations, and program swaps.

1. **Kitchener - Waterloo Microcomputer Club**
2. E2-3354 - Reading Room, Electrical Engineering Dept, University of Waterloo, Waterloo, Ontario CANADA N2L 3G1
3. Room 3388 Building Eng 4 University of Waterloo
4. First Wednesday of the month
5. None
6. Roger Sanderson
7. Home 885-2122, Work 885-1211 Ext 3815
8. None
9. All areas of microcomputing, especially hardware.

1. **North London Hobby Computer Club**

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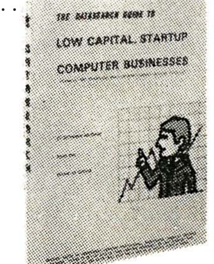
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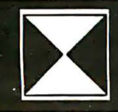
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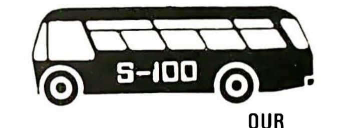
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2. c/o D.E.C.E. Polytechnic of North London, Holloway Rd, London N78DB ENGLAND
3. Polytechnic
5. *Gigo* (bimonthly)
6. Robin Bradbeer
7. 01-607-2789
8. £10 (1978/9)
9. Homebrew workshop; PET users group; games workshop; business users workshop; and Nascom workshop.
10. Regular courses on programming, digital electronics etc run by Polytechnic of North London for the NLHCC. £5 per course per member.

1. **Japan Microcomputer Club**
2. Kikaishinko-kaikan, JEIDA 5-5-8, Shiba-koen, Minato-ku, Tokyo JAPAN
3. Tokyo
5. *Microcomputer Magazine* (monthly), *Microcomputer Circular* (monthly), *Microcomputer News* (English version, unperiodically), *Microcomputer Handbook* (annually)
6. Koji Yada
7. 0424-61-2141
8. Y3000 subscription, Y6000 dues, Y4800 for students
9. Microcomputer contest (twice a year); microcomputer seminar (20-30 times a year); and a Sunday school.
10. The main language is Japanese. We have about 2500 members in our 7 branches in Japan.

1. **Microtel-Club**
2. 9 rue Huysmans, 75006, Paris FRANCE 0 544 70 23
5. Yes
8. $35 per year
9. The club's aim is to develop the interest of the French population in the microcomputer and telecommunications areas. We strive to give our members the opportunity to use and compare microcomputers. We support the most interesting projects of the club's users and promote exchanges among them.

1. **Microcomputer Club**
2. fte de Quijote #5, MEXICO 10, D.F.
6. Alfredo Buzali
7. 5-89-22-79 between 7 and 8 PM
9. Primarily concerned with the Apple II and Ohio Scientific products.

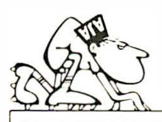
1. **Hobby Computer Club**
2. Christinastraat 171, 5 615 RK Eindhoven, NETHERLANDS
3. At 12 places throughout Belgium and the Netherlands.
4. Meetings are held at least monthly depending on the organizer.
5. *Hobby Computer Club Nieuwsbrief* (Dutch)
6. Erik Visser, Secretary
7. Netherlands 040-514017
8. 15 guilders for 1979, will increase for 1980 (225 Belgian franc)
9. No special favor for any computer or microprocessor. The main goal of the HCC is to increase contacts between computer amateurs, to exchange ideas and experiences.
10. Our A5-sized bimonthly *Nieuwsbrief* will be a full-sized monthly in 1980. Once a year we organize the HCC Day with a complete exhibition and a program of readings. Our yearly members list shows which computer is used and each member's applications. The HCC now has over 2300 members in Belgium and the Netherlands.

1. **Singapore Microcomputer Society**
2. 43K, Ponggol Rd, Singapore, 19, REPUBLIC OF SINGAPORE
6. Jack Page
7. 4680944
8. $25 per year
9. To develop and encourage by all appropriate means the wider understanding and general use of microcomputers and related systems in new and productive applications.

1. **Transvaal Amateur Computer Club**
2. POB 6639, Johannesburg, SOUTH AFRICA
3. University of the Witwatersrand, Johannesburg
4. First Wednesday of every month, excluding January
5. Newsletter published monthly
6. Angus Anderson, Peter Hers
7. 784-3532 and 793-1576, respectively
8. R10-00 per year, no entrance fee
9. All aspects of small computers.
10. TAC² was formed in July 1977. Paid membership is now 210. Club members have developed and built their own machine, based on Motorola 6800 processor with their own 42-pin bus.

1. **Central Program Exchange (CPE)**
2. Department of Computing and Mathematical Sciences, The Polytechnic, Wulfruna St, Wolverhampton WVI 1LY UNITED KINGDOM
5. *Program Exchange*
6. Dr G Beech, Project Director
7. 0902 27371 Ext 159
8. Annual subscription United Kingdom and Europe £25. Overseas £40
9. New category of membership to encourage schools and other small users. Small user subscription is £10 per year and £20 overseas. CPE has published a booklet of computer programs suitable for use in schools: *Computer Resources for Education and Training - Schools Education* price £3.50 per copy.
10. Our library contains about 300 programs in various subject areas. ■

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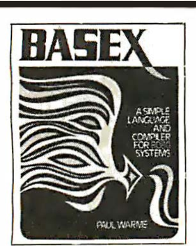
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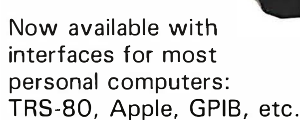
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Book Reviews

Practical Microcomputer Programming: The Intel 8080

by W J Weller,
A V Shatzel, and H Y Nice
Northern Technology Books
POB 62, Evanston, IL 1976
306 pages hardcover
6½ by 9¼ inches
$23.95

Practical Microcomputer Programming: The M6800

by W J Weller
Northern Technology Books
POB 62, Evanston, IL 1977
288 pages hardcover,
6½ by 9¼ inches
$23.95

Practical Microcomputer Programming: The Z80

by W J Weller
Northern Technology Books
POB 62, Evanston, IL 1978
481 pages hardcover,
6½ by 9¼ inches
$32.95

Practical Microcomputer Programming is a series of books begun in 1976 and masterminded by Walter Weller. Mr Weller is an applications software consultant specializing in the industrial, medical, and educational uses of small computers, and is the founder of Northern Technology Books, the publishers of this series.

It is quite obvious that Mr Weller has a natural feel for how to present such technical material. Each book is presented in lucid, readable terminology, and the layout is carefully designed to treat each topic separately and completely. This gives the reader not only a tutorial workbook to learn more about the art of assembly language programming, but also an excellent reference text which will be used time and again in preparing new projects.

The objective of the series is to directly address the difficulties of microcomputer application programming in assembly language as simply as possible. Although many programmers see little need to get embroiled in the complexities of an assembly language when a higher level language such as BASIC is available, there are indeed many applications in which a program in assembly language is desirable. In some applications it is absolutely necessary. Two important considerations in choosing to use an assembly language are necessary memory restrictions and speed.

First, recall that this series was begun in 1976. At that time most programmers doing work on microcomputers did not have the amount of memory thought of as common today. Presently programmers think nothing of talking about 64 K byte systems, and while such a large amount of memory is still not cheap, nonetheless it is within the realm of affordability, or at least will be in the very near future. In 1976, however, it was rare to think in terms of more than 4 K bytes of memory; consequently, getting a program to execute with the least amount of memory was paramount. A high-level language was a luxury few could afford. Therefore, in 1976 minimum memory requirements were quite important. But what about now, when a 64 K byte chip is within the foreseeable future?

Obviously there are still many times when a minimum amount of memory should be used. There are many industrial applications which still require strict conservation of available memory. Today there is hardly a major home appliance or piece of office equipment that does not have a microprocessor controlling it, and it certainly is not cost effective to provide each of these machines with the 16 or 32 K bytes of memory necessary to support programming them in a high-level language. But there is one other consideration for using assembly language: speed.

Speed is one of the major reasons that assembly language programming retains strong adherents. Assembly language programming is necessary to handle various tasks such as interfacing software, input and output handlers, and real-time controllers, because the electronics involved keeps getting faster. Assembly language programming is often a must for the transfer of data between any of several devices at a rate consistent with the speeds at which these devices operate.

There is another good reason for wanting to learn assembly language programming. There isn't an exact term to describe it, but words like fun, self-fulfilling, and fascinating partially describe the feeling one has after mastering assembly language programming. It lets you into that mystical world of the system programmer, it allows you to become intimate with the most inner workings of your computer, it lets you feel in total control of the sometimes awesome power the computer engenders. All in all, the individual becomes a more effective, confident, and efficient programmer.

What has all this to do with this series of books? It is Walter Weller's contention that learning to program in an assembly language should be a painless, rewarding

experience. There is nothing inherently intimidating about assembly languages, yet they have acquired a reputation guaranteed to frighten the novice programmer. It was apparently Mr Weller's goal from the beginning to present the fundamental concepts of assembly language programming in a completely nonthreatening way. He has accomplished this goal better than any other author to date.

Each book of this series is a completely self-contained guide to the assembly language of a particular microprocessor. Each is packed with examples of assembly language routines which perform real functions useful to the novice programmer. These routines not only supply the reader with instant software for a variety of applications, but also abundantly illustrate the usefulness of assembly language programming. I found each book of the series to be logically designed, including chapters detailing one particular area of assembly language programs, appendices with source listings of significant software, and a comprehensive index making it easier to use the books as reference texts.

These books are *not* exhaustive discussions of the programming characteristics of a particular microprocessor, nor do they represent complete details on all possible assembly language programming techniques. What these books do represent is a suitable cross-section of techniques that will aid the novice assembly language programmer in sharpening skills, while serving as an excellent reference resource for the experienced programmer. As for the particular microprocessor each book covers, the discussion is specific and to the point, not theoretical or general.

One final comment on the series as a whole before discussing particular details of each book: every line of code printed in each book has been checked and rechecked, right up to the moment before the book is actually printed. This helps eliminate annoying typesetting errors in the listings. While this does not absolutely guarantee the correctness of the examples or programs listed, it certainly goes much further in doing so than most publishers care to pursue. This represents a tremendous plus to the reader.

The Intel 8080 is the first book of the series, published in 1976. Although the 8080 is one of the older microprocessors on the market, there are several manufacturers (including Heath Company and Compucolor Corp) still basing their systems on this chip. In other words, this book still applies to a large number of machines currently available.

There are over 80 example programs used to illustrate the solutions to common problems facing the assembly language applications programmer. These examples are practical as well as explanatory and can often be used directly to form parts of applications programs.

The authors cover a lot of territory in the 18 chapters, 3 appendices, and index of this book. They naturally begin with binary arithmetic and logical (AND, OR, NOT) operations, bringing the programmer familiar with high-level languages, but not assembly language "down" to the proper level of thinking. Next, a definition of what constitutes memory and how it is accessed in a microcomputer is covered, which gives the novice assembly language programmer a basic idea of where things are located inside the machine.

After the preliminaries are out of the way, the authors describe the parts of an assembly language program, such as labels and operands. Also discussed are assemblers, cross-assemblers, and loaders.

Chapter 4 begins the detailed descriptions of 8080 instructions, including moving data, binary arithmetic, software multiplication and division, and using the stack pointer. Chapter 8 then employs what has been learned so far to construct a number of commonly required subroutines.

Next, binary-to-decimal and decimal-to-binary conversions are covered, allowing the programmer to format input and output, which is the subject of the next chapters: communicating with a terminal, and controlling a printer. Other types of communication to the physical world, such as digital and analog output, are also discussed.

Chapters 16 and 17 cover a topic usually omitted from a programming guide, interrupt-driven processes. First, the concept of a real-time clock and its uses are discussed, then the necessary considerations of real-time input and output are detailed. While the novice programmer may not be able to use the information in these 2 chapters immediately, the authors clearly show that progressing to that level is not that difficult, and the added flexibility of being able to take real-time events into account is of great benefit to the assembly language programmer.

The final chapter discusses many helpful ways to debug assembly language programs, the bane of many a programmer. Techniques here are illustrated using the authors' own debugging program, a tool serious programmers can not afford to be without. It allows inspection and modification of memory, single-step execution via breakpoints, and many other handy techniques. The authors have included the source code of this program in the book, which is a real bonus.

In addition to the debug program listing in the appendices, the authors have also included the source listings of the cross-assembler and loader used on the Computer Automa-

tion LSI/2 to produce object code for the 8080. This assembler will assemble all hardware instructions detailed in Intel's document #98-004C Rev C, *8080 Assembly Language Programming Manual*, plus "certain compound and pseudo instructions." What this means is that, throughout the text, the authors have chosen to use different mnemonics for certain instructions, "for clarity." An example is ReSet Carry (RSC) instead of ORA A. The authors' intentions are certainly appreciated, but it is unclear whether or not this offers an advantage to the programmer just learning 8080 assembly code, especially if he or she has access to an assembler which uses Intel mnemonics. Certainly it is easier to remember that RSC means reset carry (as opposed to ORA A), but is it realistic to assume that the reader will be in a position to take advantage of the improvement?

Only a few of the dozens of mnemonics were "improved," so hand translation is not difficult. The authors have been careful to identify which ones were changed, and the comprehensive index makes locating references in the text simple.

Once author Weller had put together a winning combination of information, he knew not to tamper with success. The M6800 and Z80 books have essentially the same information that the 8080 book does, but naturally there are specific differences for these microprocessors. There are a few differences in the conclusions, such as chapters on floating point arithmetic in the M6800 and Z80 books, and graphic output in the Z80 book, but by and large, each book covers the same general territory. In essence, then, Weller has written the same book 3 times. This certainly has its advantages, because now it is easy to compare the performance and instruction characteristics of these 3 microprocessors.

In the M6800 book, Weller again provided a listing for a debugging program as part of the appendices. As in the 8080 book, a number of the instruction mnemonics as defined by Motorola were found not suitable, and so Weller made a few substitutions of his own mnemonics (for example, DATA instead of FCB). As long as the reader is aware that this is happening (which the author points out in the preface), he or she will not have any trouble following the discussions.

Weller's Z80 book turned out to be a more ambitious project, however. It includes a complete description and source code listing of an assembler of Weller's own design, in addition to the by now anticipated debugging monitor. These programs are available in paper tape or TRS-80 cassette form from the publisher, free of charge with the return of the coupon from the book.

In the Z80 book, Weller also chose to go his own way with the assembly language mnemonics, even more so than with the M6800 and 8080 instruction sets. Essentially, he felt that Zilog did a great disservice to 8080 owners by completely redefining the mnemonics of their chip, even though a great part of the instruction set is exactly the same as that of the 8080. In actuality, the Z80 instruction set is an extended 8080 instruction set, except that Zilog used a different set of mnemonics for the instructions the Z80 has in common with the 8080.

All this means is that those who are experienced in 8080 assembly language are forced to learn an entirely new set of mnemonics for the Z80, even though the actual execution of the instructions would be exactly the same as before. Weller perceived this as an injustice to 8080 users; that being the case, his assembler merely extends the 8080 instruction set to include the full use of Z80 instructions. This approach will obviously alienate some Z80 users, but no doubt will please those upgrading from an 8080 based system to a Z80. The author also provides a complete table which translates the mnemonics he uses in his assembler and debugger to the Zilog mnemonics. I prefer not to take sides in this matter, but I can't help but admire Weller for taking a stand for simplicity.

Practical Microcomputer Programming is a very powerful series. It is well written and full of essential techniques for the assembly language programmer. The final question is: "what is next for Walter Weller?" The author intends to continue the format used for the Z80 book and provide a complete assembler for the 6502. He is hard at work on this assembler, and hopes to publish the book around the beginning of 1980. At long last 6502 users will have a definitive resource for this much neglected microprocessor. I am sure that the book will be well worth the wait.■

Blaise W Liffick
Senior Book Editor
Byte Publications



A Message to our Subscribers

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An ASCII String Program

William Comer, 419 Blackman St, Lake Charles LA 70605

Programming long American Standard Code for Information Interchange (ASCII) strings or a large number of strings can be a tedious job. The Motorola 6800 program in listing 1 simplifies the task by automatically setting up the proper hexadecimal codes in the ASCII string. This program assumes you are using a 6800 system with the Motorola MIKBUG monitor program. You simply type in the statements you want printed during execution of a machine language program. The starting address of the ASCII string is stored in hexadecimal locations A000 and A001 (high- and low-order byte respectively) before executing the program.

Using the Program

When a point is reached where you want to insert the text in your machine language program:

- Load the program starting at hexadecimal memory location 0100.
- Load the starting address of the ASCII string at hexadecimal address A000 and A001.
- Load the starting address of the program into hexadecimal memory locations A048 and A049 (01 in A048, 00 in A049).
- Start the program by typing G.
- Type in the statements exactly as you want them printed.
- Return to MIKBUG control by hitting the reset button.

Listing 1: M6800 program to load ASCII characters into memory using MIKBUG and MP-C Interface.

Address	Hexadecimal Code	Label	Op Code	Operand	Commentary
0100	CE 80 04	START	LDX	#PIAD	
0103	A6 00	IN1	LDAA	0,X	Look for start bit.
0105	2B FC		BM1	IN1	
0107	6F 02		CLR	2,X	Set counter for ½ bit.
0109	8D 28		BSR	DE	Start timer.
010B	8D 22		BSR	DEL	Delay ½ bit time.
010D	C6 04		LDAB	#4	Set delay full bit time.
010F	E7 02		STAB	2, X	
0111	58		ASLB		Set up counter with 8.
0112	8D 1B	IN3	BSR	DEL	Wait 1 character time.
0114	0D		SEC		Mark commentary line.
0115	69 00		ROL	0, X	Get bit into CFF.
0117	46		RORA		CFF to AR.
0118	5A		DECB		
0119	26 F7		BNE	IN3	
011B	8D 12		BSR	DEL	Wait for stop bit.
011D	84 7F		ANDA	#$7F	Reset parity bit.
011F	81 7F		CMPA	#$7F	
0121	27 E0		BEQ	IN1	If rubout, get next character.
0123	FE A0 00		LDX	ASSA	ASCII string start address.
0126	A7 00		STAA	0,X	
0128	08	INX			
0129	FF A0 00		STX	ASSA	
012C	7E 01 00		JMP	START	
012F	6D 02	DEL	TST	2, X	Is time up?
0131	2A FC		BPL	DEL	
0133	6C 02	DE	INC	2, X	Reset timer.
0135	6A 02		DEC	2, X	
0137	39		RTS		

Listing 2: To print an ASCII string during a machine language program, insert these 2 instructions into the program.

Hexadecimal Code	Op Code	Operand	Commentary
CE XX XX	LDX	# String	Memory location. XXXX is the starting address of the ASCII string.
BD E0 7E	JSR	PDATA 1	MIKBUG subroutine to print on ASCII string.

The address in memory locations A000 and A001 is the location following the last character in the ASCII string. Read this location and insert hexadecimal 04 into the memory location listed in hexadecimal A000 and A001. This will be used as an end of text marker by a MIKBUG routine (PDATA1).

To output the ASCII string during a machine language program, insert the program section shown in listing 2. This program saves a lot of time when programming a large number of long ASCII strings. It has saved me many hours of tedious programming. ■

Table of Subroutines

Peter W Meek, 1788 Miller Ave, Ann Arbor MI 48103

If you have a subroutine in a program, it is very likely you wrote the first line on a nice even number like 5000 or 10000. Now the program is finished, and it is time to neaten it up. You type the RENumber command, but where is your subroutine now?

If you put a table of subroutines at the end of every program, as shown below, the renumber command will keep track of them for you.

```
10      REM                      START OF PROGRAM
. . .
. . .
. . .
4999    END               :      REM END OF PROGRAM
5000                             REM START OF SUBROUTINE #1
. . .
. . .
5900    RETURN            :      REM END OF SUBROUTINE #1
10000                            REM START OF SUBROUTINE #2
. . .
. . .
10900   RETURN            :      REM END OF SUBROUTINE #2
20000                            REM TABLE OF SUBROUTINES
20010   GOTO 5000         :      REM SUBROUTINE #1
20020   GOTO 10000        :      REM SUBROUTINE #2
99999   END
```

Now the destinations of the GOTOs will be changed along with the actual line numbers. A program listing will end with a clear statement of where to look for that line which seems to have a bug in it.

Of course, this can be used to keep track of any part of a program that you like. ■

What's New?

MISCELLANEOUS



Encryption Device Secures Data in TRS-80

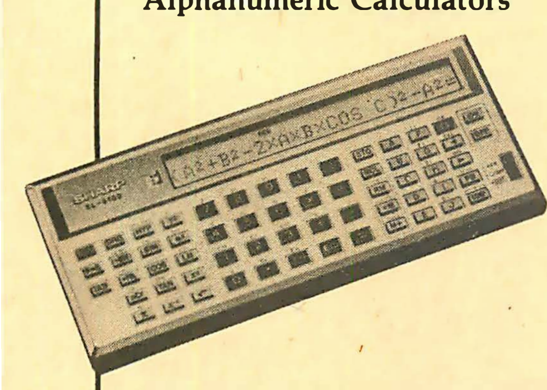
CRYPTEXT is a hardware encryption device designed to plug directly into the back of the Radio Shack TRS-80 Model I or into the expansion interface via an optional cable. The device allows users to secure virtually any data stored on cassette tapes or on disks against unauthorized access. Used with a modem, CRYPTEXT allows data or messages to be transmitted by telephone or other communication channels in complete privacy. Other uses include generating pseudorandom numbers for games or scientific programs.

Prior to encoding data, CRYPTEXT requires a user to enter a 10-character key; each of the 2^{80} possible keys results in a different and completely incoherent version of the data submitted for encryption. To decode secured data, four elements are essential: the encrypted data, the CRYPTEXT unit, the software, and the correct user-supplied key. The lack of any of these elements prevents access to the original data.

The price is less than $300 and includes demonstration software and user-oriented documentation. Optional cable and additional tape or disk software are available for a small additional charge. For further information, contact CRYPTEXT Corp, POB 425 Northgate Sta, Seattle WA 98125.

Circle 623 on inquiry card

Sharp Introduces Alphanumeric Calculators



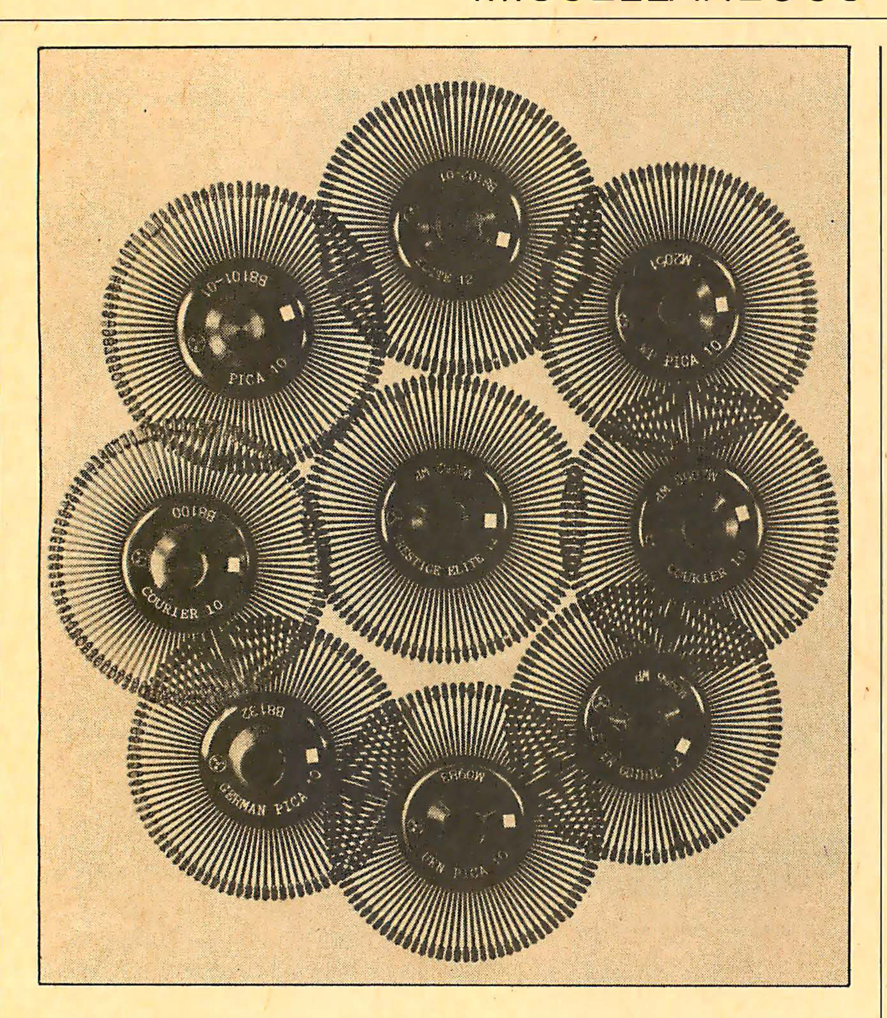
Sharp Electronics Corp has introduced two handheld scientific calculators in which alphanumeric formulae can be entered as written without being translated into machine language. The most complicated formulae can be entered into the machine and displayed, and can be visually edited, corrected, or tested without going through any translation phase. The key to the versatility of both machines in an exclusive "rolling writer" dot matrix liquid crystal display which shows numbers, letters and symbols. Because the entries roll across the liquid crystal display, as many as 80 entries can be made.

The EL-5100 has a 24-character display which can enter and store up to 80 steps, because of the rolling writer feature. It has 61 keyed functions, 10 data memories, and Memory Safe Guard to maintain data and programs even when the power is off. The EL-5100 accepts the input of complicated formulae with up to 15 levels of parentheses and 8 levels of pending operations. Complex formulae can be stored as long as needed. Five formulae, with up to 80 steps, can be stored for easy calculations and recalled at the touch of a key. Ten variables can be stored and used in the formulae.

The EL-5101 has capabilities similar to the EL-5100. It has a 16-character display which can roll to 80 characters, storage up to 48 steps, and six data memories.

Both models are wafer-thin, horizontally held, weigh just over 5 ounces, and come in a brushed metal finish. The EL-5100 is priced at $99.95 and the EL-5101 is $79.95. For further information, contact Sharp Electronics Corp, 10 Keystone Pl, Paramus NJ 07652.

Circle 622 on inquiry card



Daisy Printwheels

These plastic daisy printwheels with 96 character positions are available from AGT Computer Products Inc, 10906 Rochester Ave, Los Angeles CA 90024. They presently offer 27 Qume compatible and 13 Diablo compatible typestyles, including those which are more commonly used. These printwheels have rubber buttons with a plastic disk on the top for ease of handling. All printwheels have a metallized period, extra heavy underscore, and reinforced hub and spoke stress-points. In addition, 2 IBM compatible printwheels in Orator and OCR-B typestyles with the flip-top clasp for use in the IBM 6240 system are available. The company manufactures special wheels to order, and will modify existing molds in order to accommodate special characters or logos.

Circle 586 on inquiry card.

Portable Computer System

Called the MAScot, this complete computer system is housed in a portable carrying case. The system contains the following modular components: a 5-inch, 7 by 9 dot matrix video displaying all 128 characters of the American Standard Code for Information Interchange (ASCII) set, single or dual 5-inch floppy disk drives offering 80 to 320 K bytes of data storage, 40 or 80 column dot matrix printer, 300 or 1200 bits per second (bps) modem with built-in acoustical coupler, and 8- or 16-bit microprocessor featuring up to 1 M bytes of programmable memory. The carrying case also contains extra storage space, and the top cover is removable. The design highlights minimum size and weight combined with durability. MAScot firmware is extended BASIC, featuring integrated assembly instructions using a high-level incremental compiler. The operating system handles multidisk files.

Depending upon configuration, the price ranges from $3999 to $9999. For further information, contact Micro Application Systems Inc, 4345 Lyndale Ave N, Minneapolis MN 55412.

Circle 587 on inquiry card.

Microbench 8086 Software

A series of computer programs to support applications development for the Intel 8086 16-bit microprocessor, Microbench 8086, has been announced by Virtual Systems Inc, 1500 Newell Ave #406, Walnut Creek CA 94596. These programs operate in conjunction with PDP-11 and LSI-11 computers to provide an economical program development capability for the Intel 8086.

Included in Microbench 8086 software are a relocating assembler, linking loader, librarian, and object file formatter. The assembler supports extensive macro and conditional assembly capabilities, cross reference listings, and provides for memory addressing beyond 64 K bytes. The loader provides linkage facilities, selective loading from libraries, and directives for specifying read-only and programmable memory alignment boundaries.

The object file formatter produces binary modules in compatible formats for use with programmable read-only memory programmers and emulation systems. Microbench software is coded in Macro-11 for high throughput, and operates under RT-11, RSX-11M, RSX-11D and RSTS/E operating systems. Perpetual license fees start at $1695 including documentation and first-year maintenance.

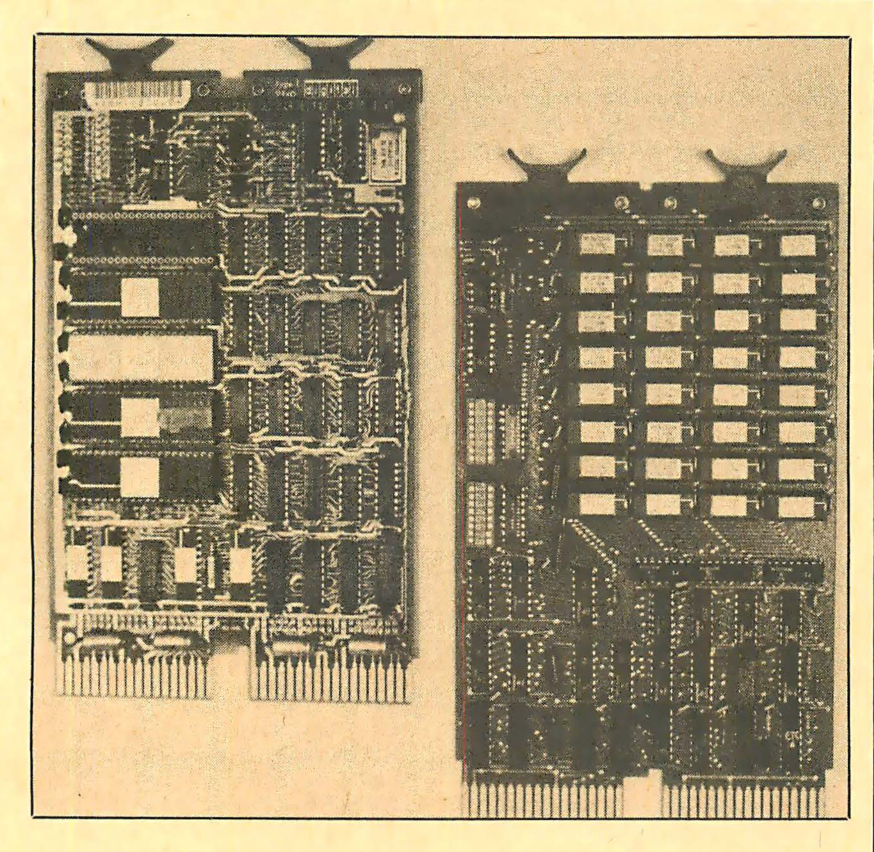
Circle 588 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgement the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first in first out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New? feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

MISCELLANEOUS

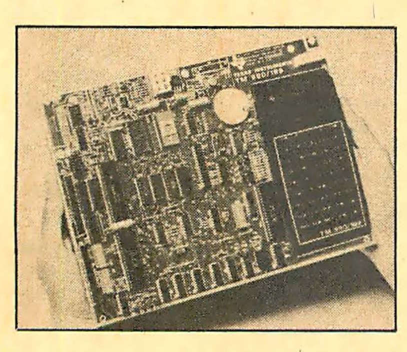


64 K Byte Microcomputer System

This 2 board microcomputer system utilizes DEC's LSI 11/2 central processing unit model KD11-HA with power fail and auto restart, 16-bit I/O (input/output) direct memory access (DMA) port, real-time clock input, vector interrupt handling, and Chrislin Industries' CI-1103 32 K byte by 16 memory board. The programmable memory module has an access time of 300 ns from synchronous active and the cycle time is 525 ns. On-board memory select is available in 2 K byte increments up to 128 K words. Complete power consumption is under 6 W. The memory is tested and burned in and warranteed for a full year. The single quantity price is $1250. For further information, contact Chrislin Industries, 31312 Via Colinas #102, Westlake Village CA 91361.

Circle 592 on inquiry card.

Single-Board Microcomputer System Designed as Learning Aid



The TM990/189M, a self-contained single-board microcomputer system, has been announced by Texas Instruments Inc. This microcomputer system is designed as a completely assembled learning aid for hands-on experience, plus instruction in microcomputer fundamentals, assembly and machine language, and microcomputer interfacing.

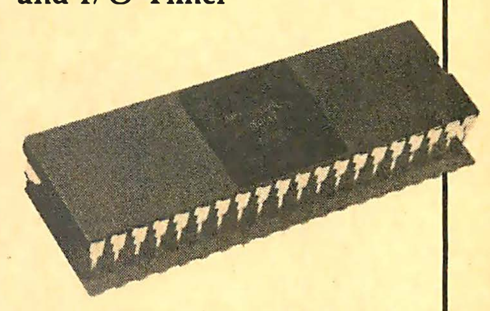
The board is self-contained with 1 K bytes of programmable memory (expandable on board to 2 K bytes) and 4 K bytes read-only memory (expandable on board to 6 K bytes). The read-only memory contains the system monitor (UNIBUG) and a symbolic assembler. Mass memory storage can be accomplished with the audio cassette interface. Built into the TM990/189M is a 45 key alphanumeric keyboard and a 10 digit, 7 segment display. The display has a 32 character buffer. It may be shifted right or left to view any 10 digits of the 32 character buffer. Provisions are on the board to add an external, standard EIA terminal or teletypewriter interface.

Other features of the TM990/189M include a series of addressable light-emitting diodes (LEDs). Coupled with these visual indicators is a piezoelectric speaker for audio signals.

The TM990/189M is priced at $299 and the optional power supply (TM990/519) is $65. For further information, contact Texas Instruments Inc, POB 1443 M/S 653, Houston TX 77001.

Circle 594 on inquiry card.

Single Read-Only Memory and I/O Timer



This read-only memory and I/O (input/output) timer can be used with the S6802 microprocessor to form a complete S6800 microcomputer with only 2 integrated circuits. The new device will also work with the S6800, S6801, S6808, S6809 or the 6500 family microprocessors.

Designated the S6846, the device combines 2 K bytes of read-only memory, an 8-bit bidirectional data port with 2 control lines for a parallel interface, a programmable interval timer and counter, and programmable registers for peripheral I/O data and control. The S6846 is the first part in the S6800 family to feature an automatic hardware power on reset capability.

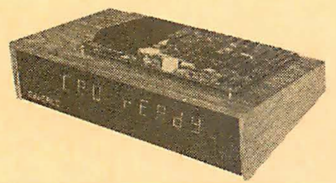
The mask programmable device is fully compatible with transistor-transistor logic as well as with other members of the S6800 family. It operates from a single +5 V DC power supply. Read-only memory code for the device can be developed on the AMI MDC-100 Microcomputer Development Center using 6800 assembly language, though specific control software for the S6846 must be user developed.

Contained in a 40-pin dual-in-line package, the S6846 is priced at $7 in plastic and $8.95 in ceramic. For further information, contact American Microsystems Inc, 3800 Homestead Rd, Santa Clara CA 95051.

Circle 593 on inquiry card.

MISCELLANEOUS

Microcomputer With Large Characters Ideal for Instruction



The EduCALC 189 GD is a 16-bit printed circuit board designed specifically for instruction. The instructor has an onboard 45-key alphanumeric keyboard and gets input, output and status information from the light-emitting diode display. Large characters on the other side of the unit repeat this display to the audience.

Assembly-language programming is featured with minicomputer instruction set; read-only memory resident software (including system monitor for program debug and symbolic assembler); single step execution; cassette interface; EIA and Teletype interface; 1 K byte programmable memory and 4 K byte read-only memory (expandable); 16-bit programmable I/O (input/output) controller and interrupt monitor; 2 MHz clock; also software and firmware compatibility with the entire TI 9900 family of microprocessors.

The price of the EduCALC 189 GD is $1074 which includes TM 990/189 board and power supply, a 570-page tutorial text, a 300-page user's guide, and a rigid carrying case. There is a one-year warranty on the neon display and interface and a 90-day warranty on the TM 990/189. Contact Educational Calculator Devices Inc, POB 974, Dept 14B, Laguna Beach CA 92652.

Circle 611 on inquiry card.

Acoustically Coupled Modem

CAT is an acoustic modem which is designed to transmit data over all telephone lines. It allows one computer or terminal to talk to another. Data exchange can occur at any speed up to 30 characters per second (300 bps). The device offers features that include Bell 103 compatibility; answer, originate, and test modes with full and half duplex; and light-emitting diodes for displaying unit status. Standard on the modem are an acoustic self-test and a compact power supply that plugs directly into wall sockets to reduce heat and voltage hazards. For further information, contact Hamilton Avnet Electronics, 10950 Washington Blvd, POB 2647, Culver City CA 90230.

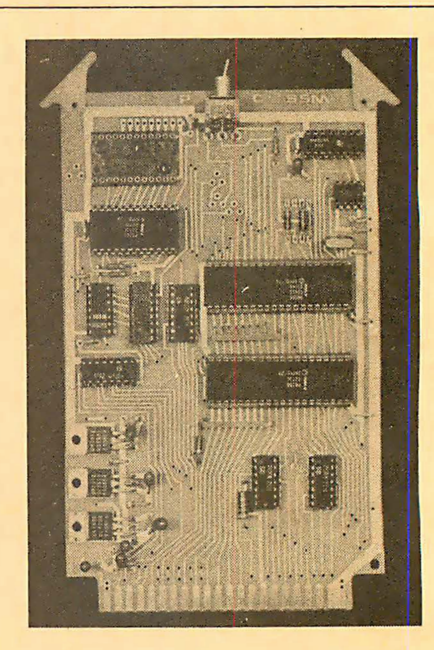
Circle 618 on inquiry card.

8085 Microcomputer Card

The SSM-85/2 is a general-purpose single-board applications control computer measuring 4.5 by 6.5 inches (11.43 by 16.51 cm). The card features a 4-level programmable interrupt; 256 bytes of programmable memory; 1 K bytes of erasable read-only memory (expandable to 2 K bytes); I/O (input/output) consists of 22 parallel lines with an additional 6-bit memory-mapped port; a serial EIA level I/O port; a programmable 14-bit binary counter and timer which is controlled by the system 3 MHz crystal and a software-readable switch. The processor has an instruction cycle time of 1.33 μs and is software compatible with the 8080A.

The SSM-85/2 assembled circuit card is priced at $197. For further information, contact System Service, 3627 Longview Valley Rd, Sherman Oaks CA 91423.

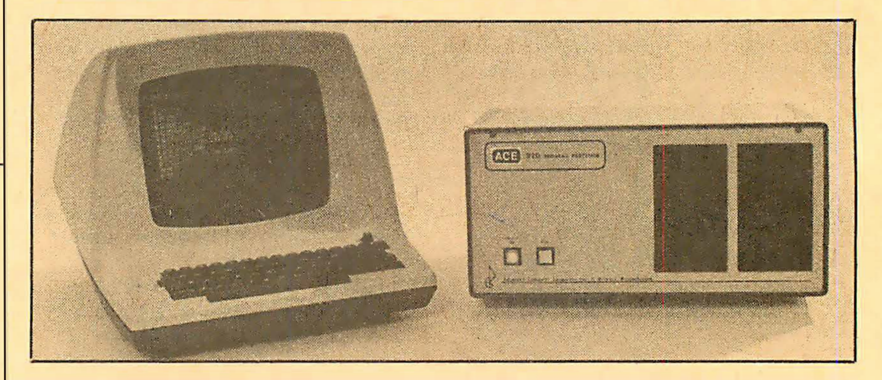
Circle 612 on inquiry card.



Manual Aids TRS-80 Users in Utilizing Level II BASIC Read-Only Memory

The *Software Technical Manual* has been written by the technicians at Houston Micro-Computer Technologies Inc to provide the assembly programmer with documentation of the TRS-80 Level II BASIC read-only memory entry points and provide working examples of their use. The manual is for the person that understands and programs in Z80 assembly language and is interested in writing fast, computer-oriented programs. It is organized in sections which emphasize different aspects of computation. The *Software Technical Manual* sells for $49.95. The address of the company is 5313 Bissonnet, Bellaire TX 77401.

Circle 613 on inquiry card.



High-Quality S-100 Cabinet

Designated the Model 2150, this industrial-quality electronics cabinet is for hobbyists and system designers using the S-100 bus. The Model 2150 features a split construction design permitting rapid, easy access to all components by the removal of two screws. Heavy duty, 22-gauge steel is used throughout. A louvered bottom panel and louvered sides plus a fan facilitate air flow for efficient thermal characteristics. Components are mounted on a separate, removable chassis enabling rapid troubleshooting. One or two 5-inch disk drives are mounted in electrically shielded enclosures protecting media from spurious noise. A fully shielded and terminated 8-slot backplane is totally compatible with the S-100 bus.

The Model 2150 electronics cabinet is priced at $795. For further information, contact Advanced Computer Equipment Inc, 3 Republic Rd, N Billerica MA 01862.

Circle 619 on inquiry card.

What's New?

MISCELLANEOUS

Video Timer and Controller Device from Texas Instruments



This single device video timer and controller has been announced by Texas Instruments Inc, POB 1443 M/S 6404, Houston TX 77001. A silicon gate, N-channel metal-oxide semiconductor (MOS) device, the TMS9927, offered in a 40 pin dual-in-line package, generates video display timing signals for standard and nonstandard video monitors that incorporate both interlaced and noninterlaced formats.

The TMS9927 may be used with either 8- or 16-bit processors, including the TMS9900 family as a memory mapped I/O (input/output) device. It can also communicate with the communications register unit (CRU) interface of the TMS9900 family via the TMS9901 programmable systems interface.

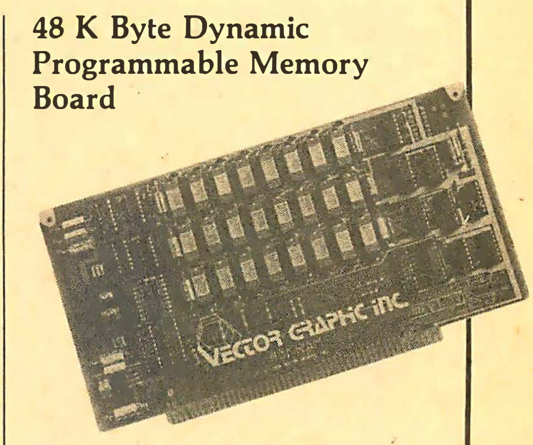
Five sections comprise the new video timer and controller: processor interface, cursor control, horizontal control, vertical control, and self-load. The video timer and controller provides 9 user programmable control registers. Seven registers control horizontal and vertical formatting, and 2 control the cursor address.

The architecture of the TMS9927 is intended to allow maximum design flexibility. Most raster scan videos may be controlled by the TMS9927 by appropriately programming the control registers. The TMS9927 is interchangeable with Standard Microsystem Corporation's (SMC) CRT 5027.

Priced in 100 piece quantities, the TMS9927 video timer and controller is $22.50 in plastic and $27 in ceramic.

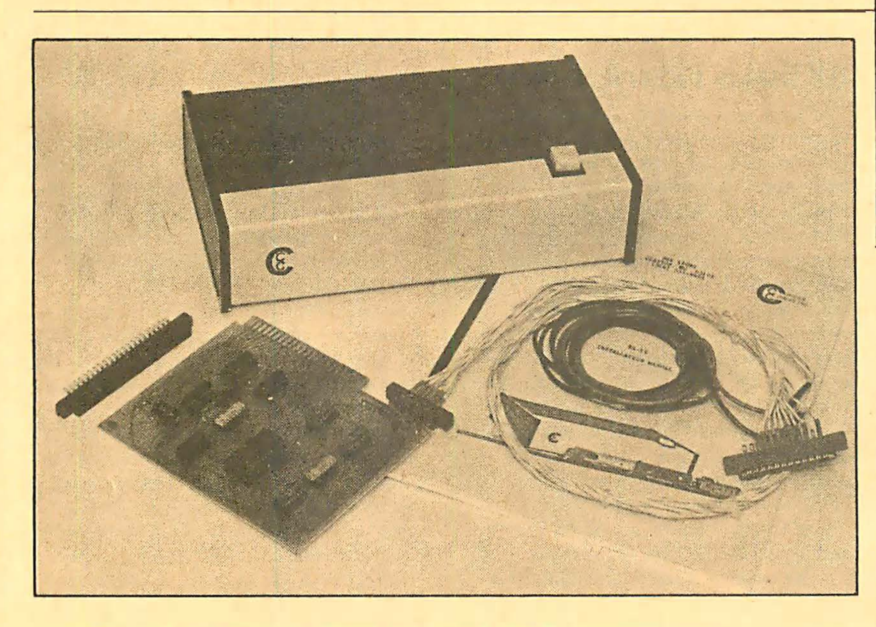
Circle 595 on inquiry card.

48 K Byte Dynamic Programmable Memory Board



This 48 K byte dynamic programmable memory board featuring complete compatibility with Z80 based S-100 bus microcomputer systems has been introduced by Vector Graphics Inc, 31364 Via Colinas, Westlake Village CA 91361. The board incorporates the Z80 refresh mode for problem free, transparent refresh, and consumes less than 4 W of total power. Superior reliability is ensured because of a low parts count and low operating temperature. It is also tested with over 400 million error-free read and write cycles before being thermally cycled and aged. Fully assembled, the Vector Graphic 48 K byte dynamic programmable memory board is priced at $695.

Circle 596 on inquiry card.



Control System for TRS-80 and PET Computers

Able to sense up to 24 inputs and drive 16 medium power outputs, the SY-16 is a plug compatible turnkey control system with all software and hardware furnished. The 16 output devices can be any 6 V or less on/off mechanism using less than ¼ A. Relay coils can be driven directly. By selecting a 6 V relay with appropriate contacts, AC signals and power can be switched, controlling most equipment originally designed for manual operation.

Input devices can be transistor-transistor logic (TTL) gates, or any form of switch contacts, including thermostats, reed switches, microswitches, joysticks, keyswitches and numeric keypads. The SY-16 can sense open or closed conditions. Up to 8 switches can be wired for fast operation. A switch closure can be captured and held, or noisy contacts can be debounced.

A software timing and control program (STAC) allows the user to specify and execute complex timing, sensing, and control sequences without having to program or write programs which call STAC as a subroutine. An interactive program is also furnished to help design sequences and experiment with them.

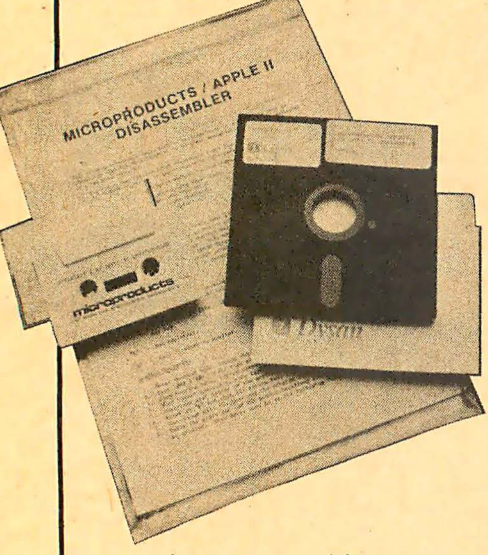
The SY-16 comes completely assembled, tested and ready to plug into TRS-80s (model T) or PETs (Model P) with software and comprehensive instruction manual describing sequence design, I/O (input/output) device control, STAC operation, and example applications for $289. The instruction manual is available at $12 and refundable upon SY-16 purchase within 60 days. For further information, contact Cooper Computing, POB 16082, Clayton MO 63105.

Circle 597 on inquiry card.

What's New?

SOFTWARE

Apple II Disassembler



Appletext is a powerful, new, 2-pass disassembler for the Apple II microcomputer. This programming tool disassembles any machine language program which resides in the Apple II. The disassembler creates a text file and assigns labels which enable the programmer to make them more useful. Initially, the label assignments contain the starting address of all subroutines. The disassembler will be valuable to any programmer who wants to rewrite, debug, modify, analyze, and understand the workings, functions and operation of inadequately documented programs for which there are no available source listings.

The disassembler is available on cassette with instructions for $29.95. For further information, contact Microproducts, 2107 Artesia Blvd, Redondo Beach CA 90278.

Circle 577 on inquiry card.

Cross-Assembler for 6800s

The 2-pass Macro Cross-Assembler from Hemenway Associates generates relocatable and linkable code. It requires the LNKEDT68 which is described below. Resident on a 6800 system, XA6809 lets the user immediately produce code for a 6809. It produces a listing, a sorted symbol table, a cross-reference list, and relocatable object code. This program features fast execution, full macro facility, relocation, and linking.

The LNKEDT68 system utility manipulates the relocatable file produced by the cross-assembler and Hemenway Associates' RA6800ML assembler and STRUBAL+ compiler as well, producing runable binary files with the desired relocations and linkages performed. More sophisticated than a simple linking loader, LNKEDT68 is a 2-pass, disk-to-disk program. The user can build output files without regard for the amount of programmable memory available at load time.

Versions are available for Percom, ICOM, SwTPC, Smoke Signal Broadcasting and Tano systems. The XA6809 is priced at $149.95, and the LNKEDT68 is $49.95. For further information, contact Hemenway Associates Inc, 101 Tremont St, Suite 208, Boston MA 02108.

Circle 581 on inquiry card.

Apple II Tiny Business Software

Tiny Business Inventory Management System, Accounts Receivable and Accounts Payable for the Apple II offer a realistic approach to the capabilities of the Apple II in a Tiny Business environment. Each software package requires a minimum system configuration of 48 K bytes and 1 disk drive and an optimum configuration of 2 disk drives and floating point firmware. The Inventory Management System supports 820 separate inventory items and quantities to assist the user in evaluating stock sales. The Accounts Payable and Accounts Receivable software handle 150 accounts each. All software packages have password protection to allow the user security on sensitive portions.

The Inventory Management System is priced at $100, while the Accounts Payable and Accounts Receivable software is $75 each. For further information, contact Custom Computing Systems Inc, 204 2nd Ave N, Saskatoon, Saskatchewan CANADA S7K 2B5.

Circle 578 on inquiry card.

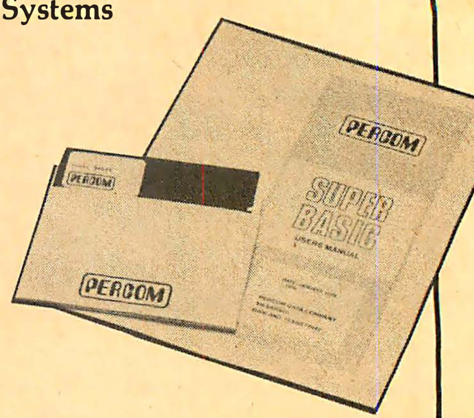
All States Payroll System

A fully user defined, all states payroll system has been announced by Payne, Jackson, and Associates (PJA), 447 E Fifth Ave, Anchorage AK 99501. Simultaneous multistate processing of up to 4 states is also possible. All standard reports with current, month, quarter, and year to date amounts, plus a limited report generator are included. The system supports 3 and in some cases 4 levels of control to permit the maximum in flexibility within a given payroll. The standard controls are used for company-wide items, while the exception controls and override controls are used for specific employees. Small and simple payrolls are also easily handled.

The system runs on an Alpha Micro and is part of the PJA Accounting System which is currently available for $500.

Circle 579 on inquiry card.

Super BASIC for 6800 Computers Using PerCom 5-Inch Floppy Disk Systems



PerCom Data Company has announced Super BASIC for 6800 computers using PerCom's LFD-400 or LFD-1000 5-inch floppy disk systems. An extended disk BASIC, similar in dialect to Southwest Technical Products' (SwTPC) 8 K byte BASIC, Super BASIC supports 42 commands and 31 functions. The program requires 12 K bytes of memory. Super BASIC is compatible with programs written in SwTPC 8 K byte BASIC (versions 2.0, 2.2, and 2.3). Besides additional commands and functions, it includes refinements that reduce program run times by 35 to 40 percent. Other enhancements include direct random access to disk file data; optional use of the question mark in lieu of the Print command; 9 digit binary-coded decimal (BCD) arithmetic; named disk file and batch processing capability when Super BASIC is used with PerCom miniDOS; line and character position error reporting; and fast execution of function calls.

Super BASIC is supplied on 5-inch disks and, together with a users manual, sells for $49.95. Upgrade kits for using Super BASIC with SwTPC or Smoke Signal Broadcasting Co disk systems are also available. For further information, contact PerCom Data Co, 318 Barnes, Garland TX 75042.

Circle 580 on inquiry card.



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The finest low cost, high quality electronic speech synthesizer. Programmable to any language or dialect.
Cat No. 1916 For Apple II $490

5¼" VERBATIM DISKETTES
$29 Cat No. 1148 box of 10

SSM AIO APPLE II SERIAL & PARALLEL INTERFACE
Interface your Apple with printers, plotters, terminals, modems, etc. Features one RS232 serial interface, two bi-directional 8-bit parallel ports, on board firmware. With comprehensive users manual and application notes for interfacing with many popular printers and terminals.
Cat No. 1918 kit $129
Cat. No. 1919 a&t $169

APPLE TALKER
Give your Apple the power of speech! Digitizes words and sets up a table so that these words can be called on under program control. Requires recorder + 2 mikes. This and Apple Lis'ner can be used as subroutines.
Cat No. 1691 $15.95

APPLE LIS'NER
Communicate with your Apple via speech! Use your cassette recorder and a mike. Responds to words it has learned under program control.
Cat No. 1692 $19.95

APPLE SOFTWARE
buy any 3, take 10% off

Cat No.	Description	Price	Cat No.	Description	Price
1317	Sargon Chess, 16K	19.95	1695	Tic-Tac-Talker/ Spectrum Analysis, 24K	19.95
1196	Bridge Challenger, 16K	14.95	1696	Bomber, 16K	9.95
1592	Bowling/Trilogy, 20K	7.95	1697	Rocket Pilot/ Saucer Invasion, 16K	12.95
1587	Golf, Applesoft II + 20K	7.95	1699	Star Wars/Space Maze, 16K	12.95
1701	Daily Biorhythm, 16K	7.95	1693	Music Kaleidoscope, 16K	9.95
1656	Galactic Blockade Runner, 16K	9.95	1719	Personal Finance Package, 16K	9.95
1658	Sci-Fi Game Sampler, 16K	7.95	1697	Apple 21 (Blackjack), 16K	9.95
1662	Othello III, 16K	7.95			

TRS-80

COMPUTALKER SPEECH SYNTHESIZER
The finest low cost, high quality electronic speech synthesizer. Programmable to any language or dialect.
Cat No. 1917
For the TRS80 485.00

16K TRS-80 MEMORY ADD-ON $85
Installs in minutes! Everything you need to upgrade to 16K, 32K, or 48K. Guaranteed to work in your machine.
Cat No. 1156
For TRS-80 keyboard unit
Cat No. 1156-A
Exp. Inter. Prior to 4/1/79
Cat No. 1156-B
Exp. Inter. After 4/1/79

TRS-232 SERIAL INTERFACE
Software driver RS-232 output. Interface Diablo, Teletype, TI Silent, etc., without expansion interface!
Cat No. 1199 $49.

MATCHLESS SYSTEMS TRS-80 MINIDISK DRIVE
$395
2 for $775
Faster accessing, increased data storage. Complete and ready to plug-in and go! Full 120 day MONEY BACK guarantee!
Cat No. 1375

TRS-80 DIN PLUGS
2 for $1.50
Male, plugs into keybd unit & accessories.
Cat No. 1229

TRS-80 SOFTWARE
buy any 3, take 10% off

Cat No.	Description	Price	Cat No.	Description	Price
1341	Fortran (Microsoft) L2, 48K + disk	$275.00	1481	Backgammon, L2, 16K	10.95
1725	CP/M, L2, 16K + disk	149.95	1048	Machine Language Monitor, L1/L2	23.95
1039	Renumber 4K - 48K	14.95	1042	Tarot, L1/L2, 4K	5.95
1680	Renumber, 16 - 48K + disk	19.95	1706	Music Master, L2 + 16K (plays music)	14.95
1549	Newdos+	99.95	1195	Bridge Challenger, L2 + 16K	14.95
1685	Electric Paintbrush	14.95	1186	Air Raid (real time target game) L1/L2 + 4K	14.95
1681	Syscop (copies SYSTEM tapes	9.95	1577	Personal Finance Package, L1 + 4K, L2 + 16K	9.95
1332	Level III Basic, L2 + 16K	49.00	1182	Microchess, L1/L2 + 4K	19.95
1338	Electric Pencil, cassette	95.00	1046	The Game of Life, L1/L2 + 4K	14.95
1199	TRS-232 Serial Interface	49.00			
1041	Star Trek III, L2, 16K	14.95			

S-100

TARBELL

Cat No.	Description	Price
1756	Cassette Interface kit	$120.00
1757	as above, a&t	175.00
1901	Floppy Disk Interface kit	190.00
1774	as above, bare-board	39.00
1758	Disk Basic on CP/M disk	70.00
1902	Cassette BASIC	48.00
1773	32K Static Ram kit	620.00

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A non impact desktop microprinter perfectly suited for todays personal computers, microprocessor development systems, diagnostic systems, CRT hard copy and more! 40 column.
Cat No. 1843*Parallel $445
Cat No. 1844*Serial $515

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Cat No.	Description	Price
1376	Imsai type, soldertail	$4.00
1428	Imsai type, wire-wrap	4.25
1388	Altair type, soldertail	4.00

SSM COMPUTER BOARDS
buy any 3, take 10% off

Cat No.	Description	Price	Cat No.	Description	Price
1411	IO4 kit	$139.00	1433	MB8A kit	78.00
1413	IO4 bb	26.00	1435	MB8A bb	26.00
1417	VB1B kit	129.00	1436	MB9 kit	64.00
1419	VB1B bb	26.00	1429	OB1 kit	45.00
1440	PB1 kit	129.00	1431	OB1 bb	26.00
1408	SB1 kit	150.00	1427	XB1	10.00
1410	SB1 bb	35.00	1428	Connector for XB1	4.00
1400A	MB6B kit 450ns	139.00			
1402	MB6B bb	26.00	1403	CB1 kit	119.00
1405	MB7 kit	325.00	1442	T1 (Terminator) kit	29.00
1407	MB7 bb	26.00			
1425	MB3 kit	54.00	1414	IO2 kit	48.00
1420	MB4 kit, 2 MHz	80.00	1416	IO2 bb	26.00
1424	MB4 bb	26.00			

PET

SOUNDWARE
Add music and sound effects to YOUR computer programs. Complete system with speaker/amplifier unit, volume control, earphone jack and plug in connectors. Complete Demo and Sound Composer programs included.
Cat No. 1899 PET 29.95

PET

Cat No.	Description	Price
1823	8k bytes, large keyboard; numeric keypad and graphics on keys.	$750
1824	16k bytes, large keyboard, numeric keypad and graphics on keys.	$965
1825	32 bytes, large keyboard, no graphics on keys.	$1165
1826	80 column dot matrix tractor feed printer	$965
1827	Dual drive mini floppy system, 343k net user storage capacity	$1088

PET SOFTWARE
buy any 3, take 10% off

Cat No.	Description	Price
1682	Basic Assembler for the PET	$29.95
1713	PET Graphics	14.95
1661	Othello, 8K	7.95
1700	Daily Biorhythm, 8K	7.95
1718	Personal Finance Package	9.95
1665	Bridge Challenger, 8K	14.95
1664	Microchess, 8K	19.95
1568	Qubic-4/Go-Moku, 8K	7.95
1564	Trek-X, 8K	7.95

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Circle 170 on inquiry card.

What's New?

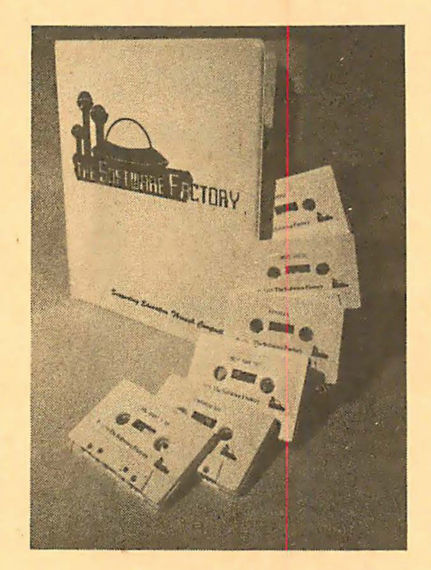
SOFTWARE

Educational Software

This educational software for the Radio Shack Level II TRS-80 and Commodore PET is designed for educators utilizing computer-assisted instruction. Currently available software includes:

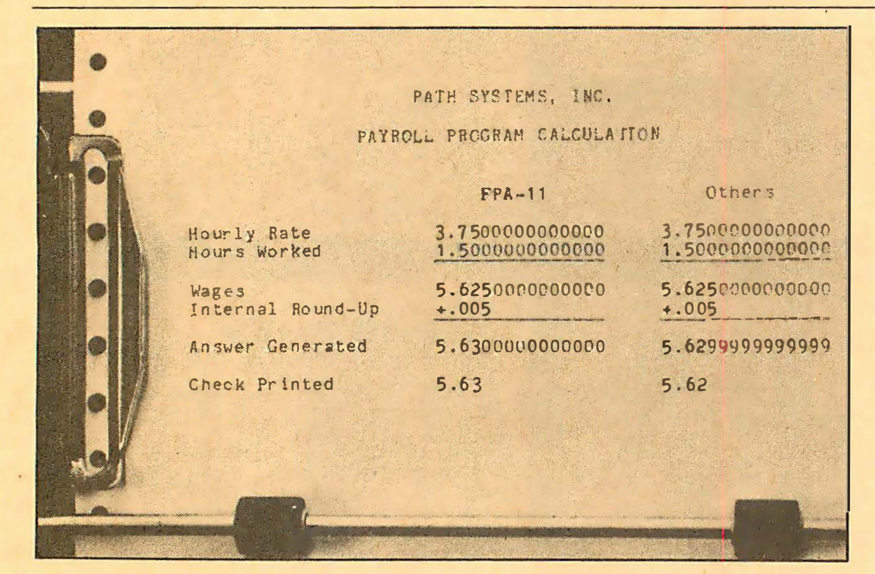
- Introduction to Microcomputers— 6 programs, 3 tapes plus teacher's guide; grades 1 through 8, at $49.95.
- Basic Math Skill Games— 12 programs, 6 tapes plus teacher's guide; grades 1 through 8, at $89.95.
- Word Problems, 6 programs, 3 tapes plus teacher's guide; primary grades, at $54.95.
- Spelling I and II— 12 programs, 6 tapes, plus teacher's guide; primary grades, at $54.95.

These complete supported programs make full use of the microcomputer's graphic capabilities and contain safeguards to minimize accidental program loss. All programs are loaded in individual cassette tapes and stored with support materials in a 3-ring notebook.



For more information, contact The Software Factory, 515 Park St, Anoka MN 55303.

Circle 603 on inquiry card.



PATH SYSTEMS, INC.

PAYROLL PROGRAM CALCULATION

	FPA-11	Others
Hourly Rate	3.7500000000000	3.7500000000000
Hours Worked	1.5000000000000	1.5000000000000
Wages	5.6250000000000	5.6250000000000
Internal Round-Up	+.005	+.005
Answer Generated	5.6300000000000	5.6299999999999
Check Printed	5.63	5.62

PDP-11 Compatible Floating Decimal Software Provides 14 Digit Accuracy

The FPA-11 Floating Decimal Arithmetic Package is a DEC PDP-11/LSI-11 compatible software program that generates answers as true decimal representations and completely eliminates strings of 9s. Offering 14 digit accuracy, it associates a scaling factor with each number to keep track of the decimal point as each calculation is performed. For fast execution, all calculations are conducted in binary form.

With a range of $10^{\pm141}$, the package is characterized by compact internal representation, and manipulated numbers are internally represented by 4 words (8 bytes). Work space is defined local to an application, and several applications can use the package on a time-shared basis. A general purpose mode lets users bypass the decimal orientation when required.

The FPA-11 Floating Decimal Arithmetic Package is priced at $75 on a floppy disk or cassette, and $135 for RK-05 compatible media. Other media can be specified. Contact Path Systems Inc, The Millyard Bldg, 333 N Turner St, Manchester NH 03102.

Circle 606 on inquiry card.

T-Ball Jotter Disk for TRS-80

The T-Ball Jotter Disk contains software for use with 32 K byte TRS-80 disk and line printer systems. It contains a collection of business and professional programs which make many types of computations and prints out many forms used in the business and investment fields such as amortization schedules and financial statements. The disk has its own master control program which enables rapid selection among operations. The T-Ball Jotter Disk is priced under $100. For more information, contact Contract Services Associates, 706 S Euclid, Anaheim CA 92802.

Circle 604 on inquiry card.

Pascal for the TRS-80

FMG Corp has announced a UCSD Pascal developmental package for Radio Shack's TRS-80. The FMG Pascal user's package is capable of running most business applications, such as word processing, payroll, accounting, and bookkeeping.

The system supports up to four floppy disk drives, line printer and RS-232 serial interface. It also supports user-implemented peripherals. The FMG Pascal developmental package includes a compiler, Z80 assembler and screen editor. It is priced at $150. For further information, contact the company at Suite 14, 5280 Trail Lake Dr, Ft Worth TX 76133.

Circle 605 on inquiry card.

File Management System

Called a Self-Indexing Query System, WHATSIT (Wow! How'd All That Stuff Get In There?) this file management system answers simple questions by referring to disk data that it stores and revises as instructed in short pidgin English sentences. Its entry-oriented indexing scheme is especially designed to combine maximum storage capacity with full cross-indexing. Applications of WHATSIT include desktop indexing of investment portfolios, music or hobby collections, customer lists, and household or professional files. Entries are automatically cross-indexed under any desired headings. Typical response time is 3 to 10 seconds.

Models are available for the Apple II and North Star systems ($100) as well as for CP/M systems ($150). Supplied on a ready-to-run disk, WHATSIT comes with a 150-page manual containing step-by-step instructions and numerous examples. Contact Computer Headware, POB 14694, San Francisco CA 94114.

Circle 607 on inquiry card.

Circle 126 on inquiry card.

The DATA-TRANS 1000

A completely refurbished **IBM** Selectric Terminal with built-in **ASCII** Interface.

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Features:

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MICRO-PROCESSORS: FROM CHIPS TO SYSTEMS

This book cover all aspects of microprocessors, from the basic concepts to advanced interfacing techniques, in a progressive presentation. It is independent from any manufacturer, and presents uniform **standard** principles and design techniques, including the interconnect of a **standard** system, as well as specific components. It introduces the MPU, how it works internally, the system components (ROM, RAM, UART, PIO, others), the system interconnect, applications, programming, and the problems and techniques of system development. By R. Zaks. SYBEX. Ref. C201. $9.95

MICRO-PROCESSOR INTERFACING TECHNIQUES

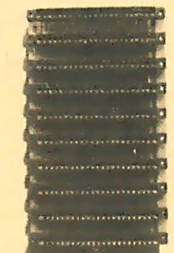
Microprocessor interfacing is no longer an art. It is a set of techniques, and in some cases just a set of components. This comprehensive book introduces the basic interfacing concepts and techniques, then presents in detail the implementation details, from hardware to software. It covers all the essential peripherals, from keyboard to floppy disk, as well as the standard buses (S100 to IEEE 488) and introduces the basic troubleshooting techniques. (2nd Expanded Edition). By Austin Lesea and R. Zaks. Ref. C207 SYBEX. $11.95

PROGRAMMING THE 6502 PROGRAMMING THE Z80 PROGRAMMING THE 8080*

It covers all essential aspects of programming, as well as the advantages and disadvantages of the 6502 and should bring the reader to the point where he can start writing complete applications programs. For the reader who wishes more, a companion volume is available: The 6502 Applications Book. By R. Zaks. 6502: Ref. C202; Z80: Ref. C280; 8080: Ref. C208. SYBEX. Each $10.95

44 BUS MOTHER BOARD

Has provisions for ten 44 pin (.156) connectors, spaced 3/4 of an inch apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost $15.00 Part No. 102. Connectors $3.00 each Part No. 44WP.



AN INTRODUCTION TO PERSONAL AND BUSINESS COMPUTING

No computer background is required. The book is designed to educate the reader in all the aspects of a system, from the selection of the microcomputer to the required peripherals. By Rodnay Zaks. Ref. C200. SYBEX $6.95

TVT COOKBOOK

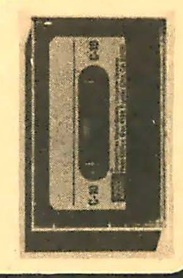
Bk 1064 — by Don Lancaster. Describes the use of a standard television receiver as a microprocessor CRT terminal. Explains and describes character generation, cursor control and interface information in typical, easy-to-understand Lancascaster style. $9.95

COMPUTER PROGRAMMING HANDBOOK

A complete guide to computer programming & data processing. Includes many worked-out examples. By Peter Staak, TAB $9.95

DIGITAL CASSETTE

5 min. each side. Box of 10 $9.95. Part No. C-5.



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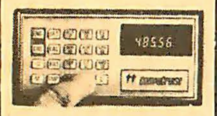
ELECTRONIC SYSTEMS Dept. B, P. O. Box 21638, San Jose, CA USA 95151

Circle 125 on inquiry card.

COMPUCRUISE

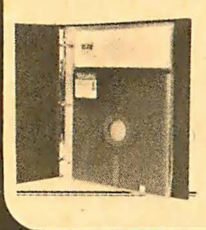
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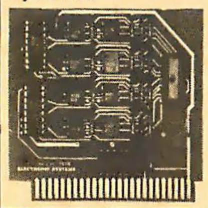
FLOPPY DISK STORAGE BINDER

This black vinyl three-ring binder comes with ten transparent plastic sleeves which accommodate either twenty, five-inch or ten, eight-inch floppy disks. The plastic sleeves may be ordered separately and added as needed. A contents file is included with each sleeve for easy identification and organizing. Binder & 10 holders $14.95 Part No. 8800; Extra holders 95¢ each. Part No. 800



OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II

There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection.
Board only $15.00. Part No. 120, with parts $69.95. Part No. 120A.



TIDMA

• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110 Part No. 112A

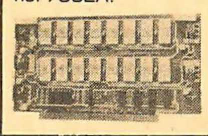


SYSTEM MONITOR

8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation $12.95.

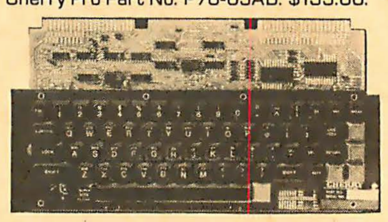
16K EPROM

Uses 2708 EPROMS, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only $24.95 part no. 7902, with parts less EPROMs $49.95 part no. 7902A.



ASCII KEYBOARD

TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. $135.00.



ASCII KEYBOARD

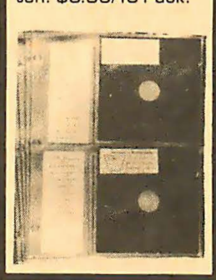
53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 Kit.

ASCII TO CORRESPONDENCE CODE CONVERTER

This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $229.95. Part No. TA 1000C

DISK JACKET™

Made from heavy duty .0095 matte plastic with reinforced grommets. The minidiskette version holds two 5-1/4 inch diskettes and will fit any standard three ring binder. The pockets to the left of the diskette can be used for listing the contents of the disk. Please order only in multitudes of ten. $9.95/10 Pack.

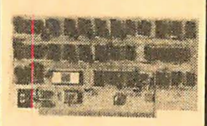


INTERNATIONAL MICROPROCESSOR DICTIONARY

English, French, Danish, German, Italian, Hungarian, Norwegian, Polish, Spanish, Swedish. 10 languages, 28 pp. SYBEX. Ref. IMD. $4.95

VIDEO TERMINAL

16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • RS-232 in • RS-232 out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & -16 VDC at 100mA, and 8VDC at 1A. Part no. 1000A $199.95 kit.



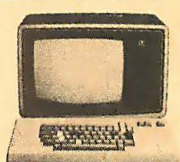
RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only $9.95, part no. 7901, with parts $14.95 Part No. 7901A.



COMPUCOLOR II

Model 3, 8K $13 95, Model 4, 16K $15 95, Model 5, 32K $18 95. Prices include color monitor, computer, and one disk drive.



PET COMPUTER

With 32K & monitor - $1195. Dual Disk Drive - $1195.



apple II or APPLE II PLUS

16K - $995, 32K - $1059, 48K - $1123. Disk & cont. $589



6502 APPLICATIONS BOOK Z80 APPLICATIONS BOOK*

This book will teach you how to connect a board to the outside world and implement practical applications for the 6502, (or Z80). Applications range from home control (a complete alarm system, including heat sensor), to industrial applications. You will learn techniques ranging from simulated traffic control to analog-digital conversion. All experiments can be realized with a minimum of external (low-cost) components. They are directly applicable to any 6502-based board such as SYM, KIM, AIM 65. This book also studies in detail input-output techniques and components, and is the logical continuation of C202 (or C280). By Rodney Zaks. SYBEX. 6502: Ref. D302; Z80: Ref D380. Each $12.95

T.V. INTERFACE

• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple • Power required is 12 volts AC C.T., or +5 volts DC • Board only $7.60 part No. 107, with parts $13.50 Part No. 107A



PARALLEL TRIAC OUTPUT BOARD FOR APPLE II



This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only $15.00 Part No. 210, with parts $119.95 Part No. 210A.

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800



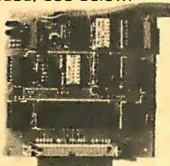
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Circle 125 on inquiry card.

TRS-80 E.S. SERIAL I/O

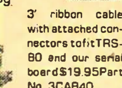
• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. O.T.R. line • Requires +5, -12 VOC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. DB25P $6.00, with 9'. 8 conductor cable $10.95 Part No. DB25P9.

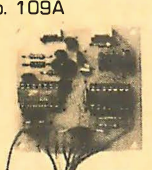


3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CA840.



MODEM

• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 Ω speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board only $7.60 Part No. 109, with parts $27.50 Part No. 109A

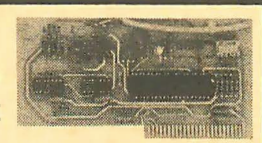


DISKETTES



Box of 10, 5" $29.95, 8" $39.95.
Plastic box, holds 10 diskettes, 5" - $4.50, 8" - $6.50.

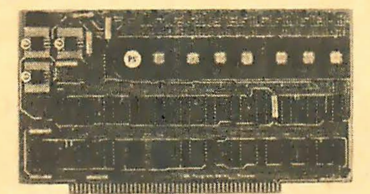
APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches OTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

8K EPROM PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • Onboard PROM programming • Address relocation of each 4K of memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.

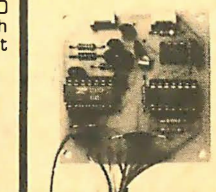


T.V. TYPEWRITER

• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A

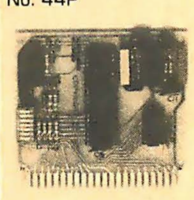
TAPE INTERFACE

• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only $7.60 Part No. 111, with parts $27.50 Part No. 111A



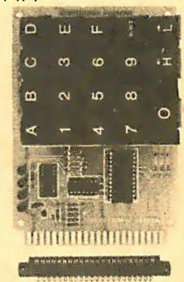
UART & BAUD RATE GENERATOR

• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P



HEX ENCODED KEYBOARD E.S.

This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.

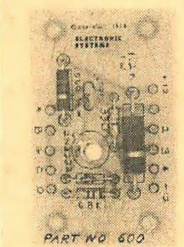


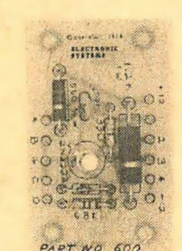
RS-232/ TTL INTERFACE

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only $4.50 Part No. 232, with parts $7.00 Part No. 232A 10 Pin edge connector $3.00 Part No. 10P

RS-232/TTY INTERFACE

This board has two active circuits, one converts RS-232 to 20mA, and the other converts 20mA to RS-232. Requires +12 and -12 volts. Board only $4.50 Part No. 600, with parts $7.00 Part No. 600A.





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EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95, $49.95 with parts less EPROMS
QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95, $67.95 Kit
MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

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Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A





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• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A



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Bare Board 49.95
Bare Board w/all parts less mem. 99.95

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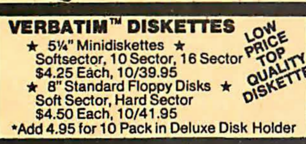
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Recommended by Alphamicrosystems

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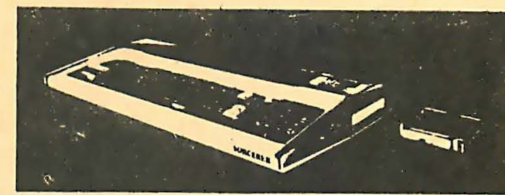
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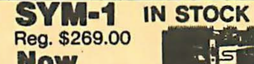


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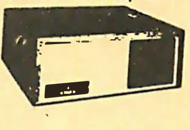
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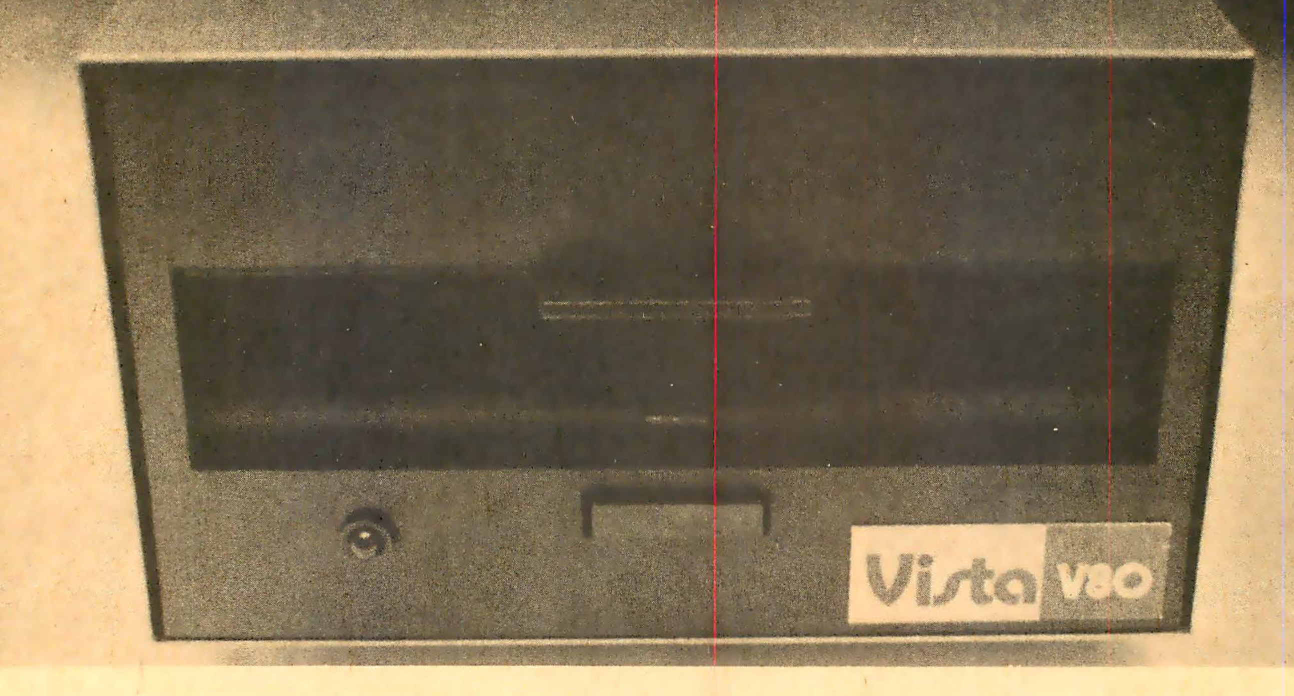
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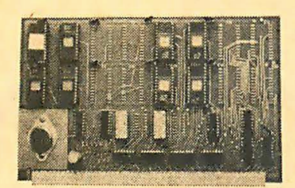
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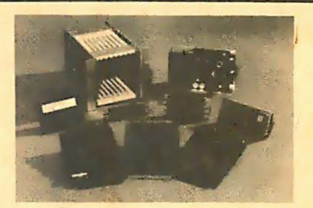



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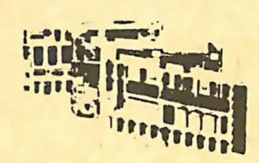
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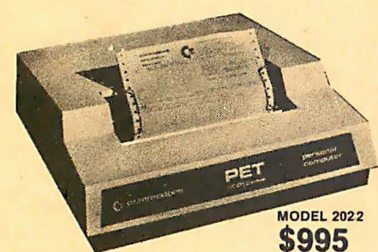
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Also included are programming capabilities for performing such useful tasks as direct-mail form-letter typing, multiple column printing, and automatic multiple forms entry. You may obtain this system in a cassette or disk drive version.

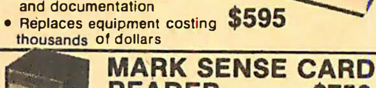
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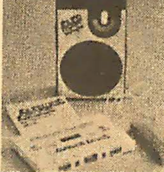
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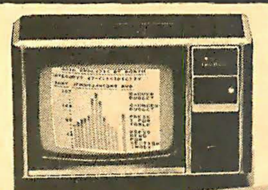
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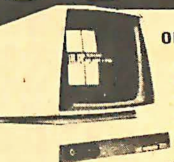


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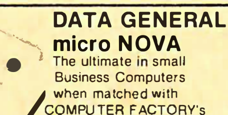
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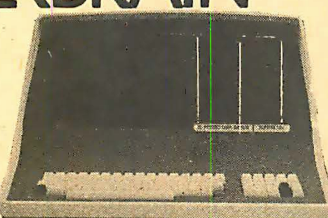


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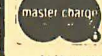
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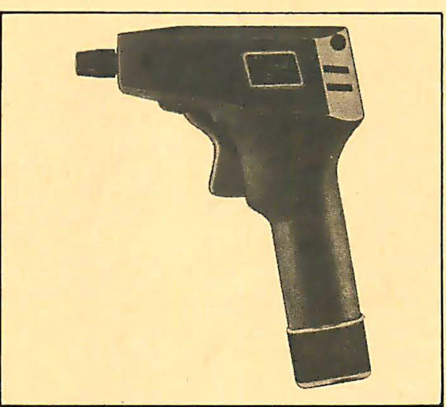
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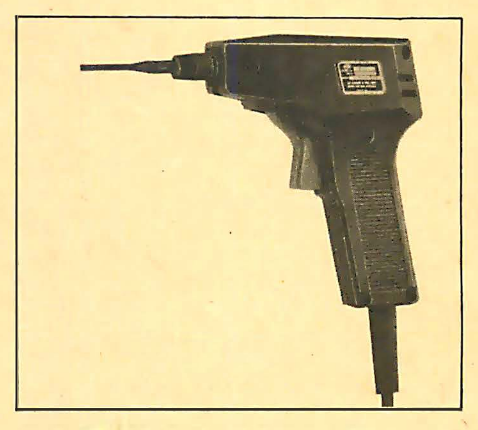
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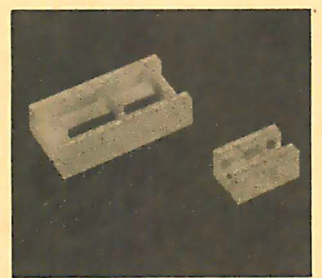
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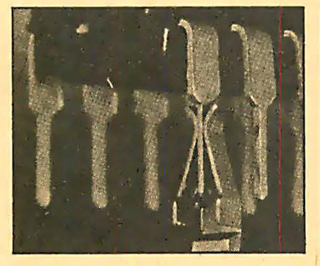
RN IC Sockets

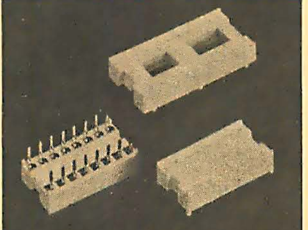
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CD4042	.99
CD4043	.89
CD4044	.89
CD4046	1.79
CD4047	2.50
CD4048	1.35
CD4049	.49
CD4050	.49
CD4051	1.19
CD4053	1.19
CD4056	2.95
CD4059	9.95
CD4060	1.49
CD4066	.79
CD4068	.39
CD4069	.45

Part	Price
CD4070	.55
CD4071	.23
CD4072	.49
CD4076	1.39
CD4081	.23
CD4082	.23
CD4093	.99
CD4098	2.49
MC14409	14.95
MC14410	14.95
MC14411	14.95
MC14419	4.95
MC14433	19.95
MC14506	.75
MC14507	.99
MC14562	14.50
MC14583	3.50
CD4508	3.95
CD4510	1.39
CD4511	1.29
CD4515	2.95
CD4518	1.29
CD4520	1.29
CD4566	2.25

74C00

Part	Price
74C00	.39
74C02	.39
74C04	.39
74C08	.49
74C10	.39
74C14	1.95
74C20	.39
74C30	.39
74C42	1.95
74C48	2.49
74C73	.89
74C74	.89

Part	Price
74C85	2.49
74C90	1.95
74C93	1.95
74C95	1.95
74C107	1.25
74C151	2.90
74C154	3.00
74C157	2.15
74C160	2.49
74C161	2.49

Part	Price
74C163	2.49
74C164	2.49
74C173	2.60
74C192	2.49
74C193	2.49
74C195	2.49
74C922	5.95
74C923	6.25
74C925	8.95
74C926	8.95
80C95	1.50
80C97	1.50

LINEAR

Part	Price
78MG	1.75
LM106H	.99
LM300H	.60
LM301CN/H	.35
LM302H	.75
LM304H	1.00
LM305H	.60
LM307CN/H	.35
LM308CN/H	1.00
LM309H	1.10
LM309K	1.25
LM310CN	1.15
LM311N/H	.90
LM312H	1.95
LM317K	6.50
LM318CN/H	1.50
LM319N	1.30
LM320K-5	1.35
LM320K-5.2	1.35
LM320K-12	1.35
LM320K-15	1.35
LM320K-18	1.35
LM320K-24	1.35
LM320T-5	1.25
LM320T-5.2	1.25
LM320T-8	1.25
LM320T-12	1.25
LM320T-15	1.25
LM320T-18	1.25
LM320T-24	1.25
LM323K-5	5.95
LM324N	1.80
LM339N	.99
LM340K-5	1.35
LM340K-6	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35

Part	Price
LM340K-18	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM358N	1.00
LM370N	1.95
LM373N	3.25
LM377N	4.00
LM380N	1.25
LM380CN	.99
LM381N	1.79
LM382N	1.79
NE501N	8.00
NE510A	6.00
NE529A	4.95
NE531H/V	3.95
NE536T	6.00
NE540L	6.00
NE544N	4.95
NE550N	1.30
NE555V	.39
NE556N	.99
NE560B	5.00
NE561B	5.00
NE562B	5.00
NE565N/H	1.25
NE566CN	1.75
NE567V/H	.99
NE570N	4.95
LM703CN/H	.69
LM709N/H	.29

Part	Price
LM710N	.79
LM711N	.39
LM723N/H	.55
LM733N	1.00
LM739N	1.19
LM741CN/H	.35
LM741-14N	.39
LM747N/H	.79
LM748N/H	.39
LM1310N	2.95
LM1458CN/H	.59
MC1488N	1.39
MC1489N	1.39
LM1496N	.95
LM1556V	1.75
MC1741SCP	3.00
LM2111N	1.95
LM2901N	2.95
LM3053N	1.50
LM3065N	1.49
LM3900N(3401)	.49
LM3905N	.89
LM3909N	1.25
MC5558V	.59
8038B	4.95
LM75450N	.49
75451CN	.39
75452CN	.39
75453CN	.39
75454CN	.39
75491CN	.79
75492CN	.89
75493N	.89
75494CN	.89
RC4136	1.25
RC4151	2.85
RC4194	5.95
RC4195	4.49

74LS00TTL

Part	Price
74LS00	.29
74LS01	.29
74LS02	.29
74LS03	.29
74LS04	.35
74LS05	.35
74LS08	.29
74LS09	.35
74LS10	.29
74LS11	.75
74LS13	.59
74LS14	1.25
74LS15	.35
74LS20	.29
74LS21	.35
74LS22	.35
74LS26	.35
74LS27	.35
74LS28	.35
74LS30	.29
74LS32	.35
74LS37	.45
74LS40	.35
74LS42	.89

Part	Price
74LS47	.89
74LS51	.29
74LS54	.29
74LS55	.29
74LS73	.45
74LS74	.45
74LS75	.59
74LS76	.45
74LS78	.49
74LS83	.89
74LS85	1.25
74LS86	.45
74LS90	.59
74LS92	.75
74LS93	.75
74LS95	99
74LS96	1.15
74LS107	.45
74LS109	.45
74LS112	.45
74LS123	1.25
74LS125	.89
74LS132	.99
74LS136	.49

Part	Price
74LS138	.89
74LS139	.89
74LS151	.89
74LS155	.89
74LS157	.89
74LS160	1.15
74LS161	1.15
74LS162	1.15
74LS163	1.15
74LS164	1.25
74LS175	.99
74LS181	2.49
74LS190	1.15
74LS191	1.15
74LS192	1.15
74LS193	1.15
74LS194	1.15
74LS195	1.15
74LS253	.99
74LS257	.89
74LS258	1.75
74LS260	.69
74LS279	.75
74LS367	.75
74LS368	.75
74LS670	2.49

EXCITING NEW KITS

NEW JE600 HEXADECIMAL ENCODER KIT

FEATURES:

- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 . . . . $59.95
Hexadecimal Keypad only $14.95

Digital Thermometer Kit

NEW

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 . . . .$39.95

DISCRETE LEDS

Part	Color	Price
.200" dia.		
XC556R	red	5/$1
XC556G	green	4/$1
XC556Y	yellow	4/$1
XC556C	clear	4/$1
.200" dia.		
XC22R	red	5/$1
XC22G	green	4/$1
XC22Y	yellow	4/$1
.170" dia.		
MV10B	red	4/$1
.085" dia.		
MV50	red	6/$1

INFRA-RED LED 1/4"x1/4"x1/16" flat 5/$1

Part	Color	Price
.125" dia.		
XC209R	red	5/$1
XC209G	green	4/$1
XC209Y	yellow	4/$1
.185" dia.		
XC526R	red	5/$1
XC526G	green	4/$1
XC526Y	yellow	4/$1
XC526C	clear	4/$1
.190" dia.		
XC111R	red	5/$1
XC111G	green	4/$1
XC111Y	yellow	4/$1
XC111C	clear	4/$1

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LIQUID CRYSTAL DISPLAY CLASS II
FIELD EFFECT

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THREE ENUNCIATORS
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INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

Part	Price	Part	Price
CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

Part	Price
MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

Part	Price
MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

Part	Price
MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	$.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	$ .37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	$.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	$ .99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100
8 pin SG	$.30	.27	.24
14 pin SG	.35	.32	.29
16 pin SG	.38	.35	.32
18 pin SG	.52	.47	.43
24 pin SG	$ .70	.63	.57
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	$.39	.38	.31
10 pin WW	.45	.41	.37
14 pin WW	.39	38	.37
16 pin WW	.43	.42	.41
18 pin WW	.75	.68	.62
22 pin WW	$ .95	.85	.75
24 pin WW	1.05	.95	.85
28 pin WW	1.40	1.25	1.10
36 pin WW	1.59	1.45	1.30
40 pin WW	1.75	1.55	1.40

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ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680OHM / 1.8K	620 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
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74C922	Keyboard Encoder (16 keys)	5.95

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ICM7045	CMOS Precision Timer	24.95
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ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

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MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
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TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
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TIL308	.27" red num. display w/integ. logic chip	10.50
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Part	Price	Part	Price	Part	Price
XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4556	.75
XR1468	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00
1N751	5.1	400m	4/1.00
1N752	5.6	400m	4/1.00
1N753	6.2	400m	4/1.00
1N754	6.8	400m	4/1.00
1N757	9.0	400m	4/1.00
1N759	12.0	400m	4/1.00
1N959	8.2	400m	4/1.00
1N965	15	400m	4/1.00
1N5232	5.6	500m	28
1N5234	6.2	500m	28
1N5235	6.8	500m	28
1N5236	7.5	500m	28
1N5242	12	500m	28
1N5245	15	500m	28
1N456	25	40m	6/1.00
1N458	150	7m	6/1.00
1N485A	180	10m	5/1.00
1N4001	50 PIV 1 AMP		12/1.00

TYPE	VOLTS	W	PRICE
1N4002	100 PIV 1 AMP		12/1.00
1N4003	200 PIV 1 AMP		12/1.00
1N4004	400 PIV 1 AMP		12/1.00
1N4005	600 PIV 1 AMP		10/1.00
1N4006	800 PIV 1 AMP		10/1.00
1N4007	1000 PIV 1 AMP		10/1.00
1N3600	50	200m	6/1.00
1N4148	75	10m	15/1.00
1N4154	35	10m	12/1.00
1N4305	75	25m	15/1.00
1N4734	5.6	1w	28
1N4735	6.2	1w	28
1N4736	6.8	1w	28
1N4738	8.2	1w	28
1N4742	12	1w	28
1N4744	15	1w	28
1N1183	50 PIV 35 AMP		1.60
1N1184	100 PIV 35 AMP		1.70
1N1185	150 PIV 35 AMP		1.70
1N1186	200 PIV 35 AMP		1.80
1N1188	400 PIV 35 AMP		3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

Part	Price	Part	Price	Part	Price
C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.69	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

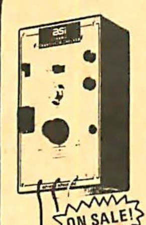
	1-9	10-99	100-		1-9	10-99	100-
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	15/25V	.63	.50	.40
1.0/35V	.28	.23	.17				

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-99	100-	Radial Lead	1-9	10-99	100-
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Circle 200 on inquiry card.

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

ON SALE!

Trans-Check $19.95 ea.

Custom Cables & Jumpers

NEW! NEW!



DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.
Dip Jumpers			
DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS
25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)		$1.95
18/36	PINS (Solder Eyelet)		$2.49
22/44	PINS (Solder Eyelet)		$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)		$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1	$6.95

4-Digit Clock Kit

* Bright .357" ht. red display
* Sequential flashing colon
* 12 or 24 hour operation
* Extruded aluminum case (black)
* Pressure switches for hours, minutes & hold functions
* Includes all components, case and wall transformer
* Size: 3¼ x 1¾ x 1¼

JE730 .... $14.95

Jumbo 6-Digit Clock Kit

* Four .630"ht. and two .300"ht. common anode displays
* Uses MM5314 clock chip
* Switches for hours, minutes and hold functions
* Hours easily viewable to 30 feet
* Simulated walnut case
* 115VAC operation
* 12 or 24 hour operation
* Includes all components, case and wall transformer
* Size: 6¾ x 3⅛ x 1¾

JE747 .... $29.95



* Bright .300 ht. comm. cathode display
* Uses MM5314 clock chip
* Switches for hours, minutes and hold modes
* Hrs. easily viewable to 20 ft.
* Simulated walnut case
* 115 VAC operation
* 12 or 24 hr. operation
* Incl. all components, case & wall transformer
* Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



Digital Stopwatch Kit

* Use Intersil 7205 Chip
* Plated thru double-sided P.C. Board
* LED display (red)
* Times to 59 min. 59.59 sec. with auto reset
* Quartz crystal controlled
* Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
* Uses 3 penlite batteries
* Size: 4.5" x 2.15" x .90"

JE900 $39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES			
8080A	CPU		$ 9.95
8212	8-Bit Input/Output		3.25
8214	Priority Interrupt Control		5.95
8216	Bi-Directional Bus Driver		3.49
8224	Clock Generator/Driver		3.95
8226	Bus Driver		3.49
8228	System Controller/Bus Driver		5.95
8238	System Controller		5.95
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8253	Prog. Interval Timer		14.95
8255	Prog. Periph. 1/0(PPI)		9.95
8257	Prog. DMA Control		19.95
8259	Prog. Interrupt Control		19.95
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MC6802CP	MPU with Clock and Ram		24.95
MC6810API	128X8 Static Ram		5.95
MC6821	Periph. Inter. Adapt (MC6820)		7.49
MC6828	Priority Interrupt Controller		12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)		14.95
MC6850	Asynchronous Comm. Adapter		7.95
MC6852	Synchronous Serial Data Adapt.		9.95
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MC6880A	Quad 3-State Bus. Trans. (MC8T26)		2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS			
Z80(780C)	CPU		$19.95
Z80A(780-1)	CPU		24.95
COP1802	CPU		19.95
2650	MPU		19.95
6502	CPU		11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines		19.95
P8085	CPU		19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide		49.95
SHIFT REGISTERS			
MM500H	Dual 25 Bit Dynamic		$.50
MM503H	Dual 50 Bit Dynamic		.50
MM504H	Dual 16 Bit Static		.50
MM506H	Dual 100 Bit Static		.50
MM510H	Dual 64 Bit Accumulator		.50
MM5016H	500/512 Bit Dynamic		.89
2504T	1024 Dynamic		3.95
2518	Hex 32 Bit Static		4.95
2522	Dual 132 Bit Static		2.95
2524	512 Static		.99
2525	1024 Dynamic		2.95
2527	Dual 256 Bit Static		2.95
2528	Dual 250 Static		4.00
2529	Dual 240 Bit Static		4.00
2532	Quad 80 Bit Static		2.95
2533	1024 Static		2.95
3341	Fifo		6.95
74LS670	4X4 Register File (TriState)		2.49
UART'S			
A-Y-5-1013	30K BAUD		5.95
MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
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1103	1024X1	Dynamic	.99
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2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	49.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES

Proto Board 203

A total ready-to-use power breadboard prototest device with a built-in regulated, short-proof power supply. Just plug-in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction. 9¾"L x 6½"W x 2¾"H 5 lbs.

PB 203 **$75.00**

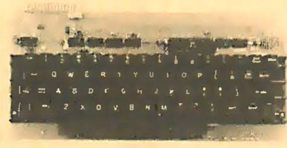
Proto Board 203A

All the features of the PB-203 plus additional power supply flexibility, provides 1%-Regulated 5VDC supply (same specifications as PB-203). Regulated separate +15VDC and −15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise of + and −15V supplies. 10mV at 0.25A.

PB 203A **$124.95**

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

62-Key ASCII Encoder Keyboard Kit



The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

FEATURES:
* 60 Keys generate the full 128 characters, upper and lower case ASCII set
* Fully buffered
* 2 user-define keys provided for custom applications
* Caps lock for upper case only alpha characters
* Utilizes a 2376 (40 pin) encoder read only memory chip
* Outputs directly compatible with TTL/DTL or MOS logic arrays
* Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... $79.95

62-Key Keyboard only . . $34.95

REGULATED POWER SUPPLY

NEW

JE200

5V-1 AMP POWER SUPPLY



* Uses LM309K
* Heat sink provided
* PC Board construction
* Provides a solid 1 amp @ 5 volts
* Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
* Includes components, hardware & instructions
* Size: 3½"x5"x2"H

JE200 $14.95

JE205

ADAPTER BOARD — Adapts to JE200 — ±5V, ±9V and ±12V



* DC/DC converter w/ +5V input
* Toriodal hi-speed switching XMFR
* Short circ. protection
* PC Brd. construction
* Piggy-back to JE200 board
* Size: 3½"x9/16"h

JE205 $12.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
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Spec Sheets — 25¢
1979 Catalog Available — Send 41¢ stamp



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The Incredible "Pennywhistle 103"



$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and It is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 ma k; High = 025 space, 2225 mark.
Receive Sensitivity	−46 dbm accoustically coupled.
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

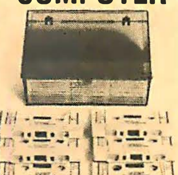
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K $75.00

COMPUTER CASSETTES



* 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
* PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
* ADDITIONAL CASSETTES AVAILABLE #C-15-1$2.95 ea

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit



Wide Band B/W or Color System
* Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
* MOD II is pretuned to Channel 33 (UHF).
* Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

Function Generator Kit

* Provides 3 basic waveforms: sine, triangle & square wave
* Frequency range from 1 Hz to 100K Hz
* Output amplitude from 0-volts to over 6 volts (peak to peak)
* Uses a 12V supply or a ±6V split supply
* Incl. chip, P.C. board, components and instructions.

JE2206B $19.95

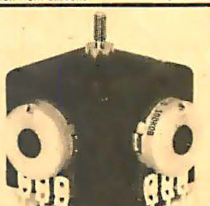
IDEAL FOR TRS 80 — CASSETTE CONTROLLER

"Plug/Jack interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.



#CC-100 $29.50



new

Micro-Miniature Joystick

* 2 each 100K pots (Linear Taper)
* Printed Circuit Board Mount
* Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick **$4.95**

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All programs on high quality cassette tape, ready for use on any Apple II System with Applesoft Liberal use of prompting allows easy use even for the novice.

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COMPUTER CAJUN CUISINE: Program computes exact amounts of all ingredients necessary for any number of servings for eight Louisiana soup and gumbo recipes: 16K - **$25.00**

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P.O. Box 73043
Metairie, Louisiana 70033

Circle 365 on inquiry card.

Moonshadow Text Formatter for UCSD Pascal Systems

The UCSD Pascal system contains a screen-oriented text editor which is convenient, but which is not suited to word processing. It cannot underline, paginate automatically, or perform other essential text-processing functions. The **Moonshadow Text Formatter** (MTF) for Merrimack Systems solves this problem.

With the Moonshadow Text Formatter, documents produced with the screen editor are *post-processed* to provide these missing functions. It takes standard Pascal text files, operates on them, and sends fully formatted text output to the console display, a printer, or a disk file.

Moonshadow Text Formatter provides, in addition to a full range of formatting functions, *advanced features* including the combination of files into one document, variables in text (for form letters), and output character translation.

The Moonshadow Text Formatter is written in UCSD Pascal. It works on systems using either North Star 5-inch floppy disks or IBM-format 8-inch floppy disks.

All this for **$99.00** *from*

Merrimack Systems
POB 5218
Redwood City, CA 94063
(415) 365-6281

California residents should include 6% sales tax.

Also available: a SOL-VDM driver that makes a SOL appear to the Pascal system like a SOROC with random cursor, for **$25.00**

Circle 216 on inquiry card.

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Join one of the fastest growing micro/mini systems manufacturers in the U.S. where your advancement is limited only by your talent and ability. Our client needs several software engineers (assembly) to contribute to the development of state-of-the-art products in such areas as diagnostics, graphics, networks, compiler and OS design, and systems software. Positions available at the intermediate and senior level. Starting salary is 18-30K. Please contact Dave Adams (617) 246-2815. Collect calls accepted. N.E. Recruiters, 6 Lakeside Office Park, Wakefield, MA 01880.

All fees and expenses paid by the company.

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Assistant Professor of Media Technology

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The job includes teaching one subject per semester and developing a research program that can grow to support graduate students. One subject should be an undergraduate survey and laboratory, the other an advanced graduate subject reflecting state of the art techniques in computers and television. Both will be designed in concern with particular interests and experience of an applicant. Candidates should include a statement about their thoughts on such curriculum developments.

The position is 50% research, again driven by a candidate's own intellectual motivations. Statements about such interests will be helpful in reviewing applications.

Applications should be addressed to Professor Leon Groisser, Acting Head, Department of Architecture, MIT, Cambridge, MA 02139 **by October 31, 1979.** The appointment to be awarded at the earliest convenience of the most qualified candidate.

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MDS-A-D	550.	640.
EXTRA DRIVE	330.	
QUAD DENSITY	**KIT**	**ASM**
HRZ-1-32K-Q	$1750.	$2040.
HRZ-2-32K-Q	2230.	2560.
MDS-A-Q	720.	800.
EXTRA DRIVE	480.	

All HORIZONS now come standard with 3 ports and all edge connectors and minimum 32K memory.

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RAM-16K W/PARITY	$300.	$345.
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Expand the PET Computer

A combination memory I/O (input/output) expander and floppy disk system for the PET computer is now available from CGRS Microtech. The PEDISK provides both a high-speed floppy disk and an S-100 expansion chassis all in one unit. The S-100 expansion will hold extra I/O and memory, such as printer, telephone interface, modem and voice I/O cards.

The floppy disk is available with up to 3 5-inch floppy disk drives (total capacity of 80 K bytes) or up to 4 8-inch disk drives (total capacity of 1 M bytes). System prices range from $799.95. For further information, contact CGRS Microtech, POB 368, Southampton PA 18966.

Circle 582 on inquiry card.

Low Cost Selectric Typewriter Interface

The MP-WP Selectric Interface is a simple, low cost interface that allows the user to connect an unmodified IBM model 50 Selectric typewriter to an SS-50 bus 6800 or 6809 computer system. Interfacing is made to the typewriter through a cable assembly that plugs into a connector provided on the typewriter. No solenoids or typewriter modifications are required. The typewriter may be used for both input and output, and will still function as a normal typewriter when not being driven by the computer.

The interface and interconnecting cable (#MP-WP) are fully assembled and sell for $59.95 postage paid. For further information, contact Southwest Technical Products Corp, 219 W Rhapsody, San Antonio TX 78216.

Circle 583 on inquiry card.

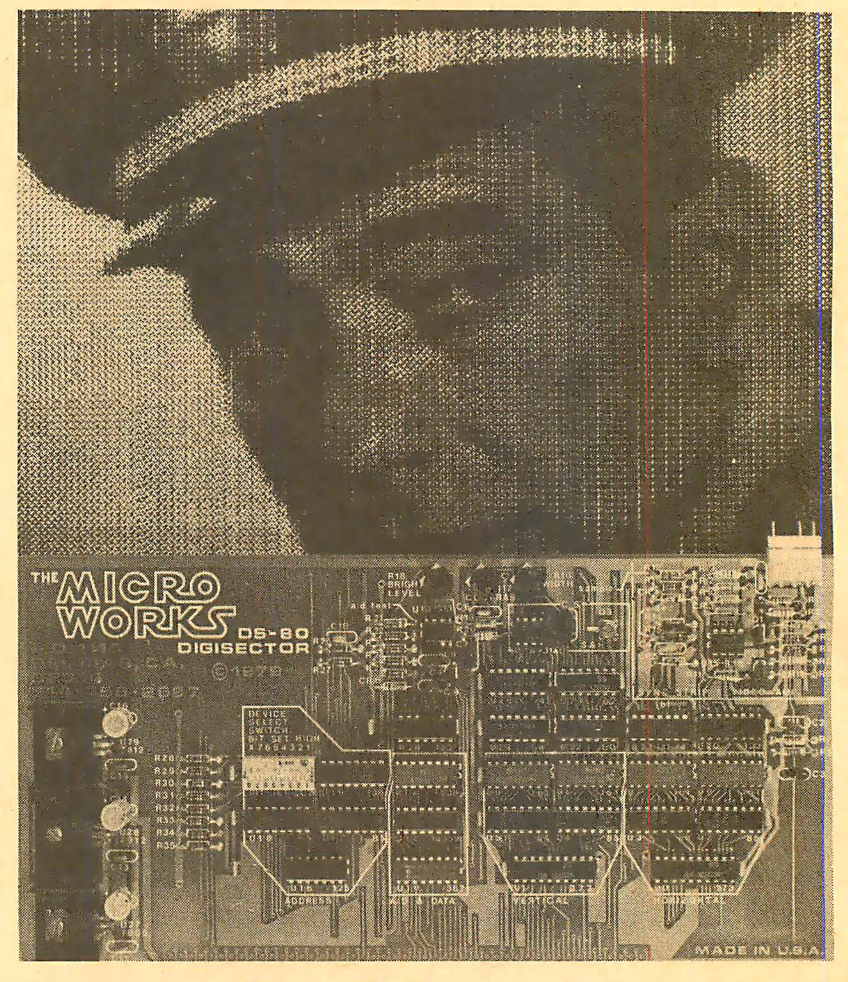
Free Brochure Describes Houston Instrument's Hi Pad Digitizer

An 8 page, 4 color brochure describing the Hi Pad Digitizer is available from Houston Instrument, One Houston Sq, Austin TX 78753. This 11 by 11 inch active surface digitizer offers user controllable features such as metric and inch capability, binary and binary-coded decimal outputs, RS-232C 8-bit parallel interface, all selectable at the interface connector.

The Hi Pad is accurate to ±0.015 inches with a resolution of either 0.01 or 0.005 inches. The data rate may be set to input up to 100 coordinate pairs per second. Four buttons on the edge of the table allow the user to relocate the origin and select point or stream modes of operation. The magnified cursor allows coordinate updating of the curve or line being traced by depressing the cursor button at points being considered.

The brochure includes prices and specifications for the Hi Pad and accessories as well as complete technical descriptions of the multiple output formats available with the Hi Pad.

Circle 584 on inquiry card.



Random Access Video Digitizer

The DS-80 Digisector is a random access digitizer with high-resolution and speed. The board provides the following features: a 256 by 256 picture element scan; 64 levels of grey scale; conversion times as low as 4 μs per pixel; accepts either interlaced (NTSC) or noninterlaced (industrial) video input; and uses 1 bus slot in any S-100 system conforming to the Institute of Electrical and Electronic Engineers (IEEE) standards.

The computer sends the Digisector 2 8-bit addresses (X and Y coordinates), and the Digisector returns the digitized brightness of the image at the specified location. For set-up and monitoring purposes, the Digisector produces an output comprised of the camera's video signal plus a superimposed cursor, showing exactly where the DS-80 is looking.

The software supplied will digitize 1 pixel every other horizontal scan-line, filling 8 K bytes of memory with 2 4-bit grey scale values per byte in a little less than 2 seconds. It provides spatial resolution of 128 by 128 elements, optimum for computer-portraiture and slow-scan television. This software is compatible with the Vector Graphic High-Resolution Graphics Display Board. Additional routines are provided to drive both graphics and American Standard Code for Information Interchange (ASCII) printers.

The Digisector comes fully assembled, tested, and burned-in and is priced at $349.95. For further information, contact Micro Works, POB 1110, Del Mar CA 92014.

Circle 585 on inquiry card.



Circle 137 on inquiry card.

Circle 384 on inquiry card.

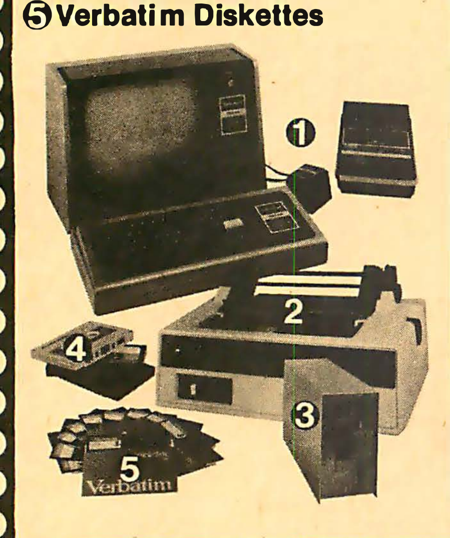
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1070	40/80 S/E PET	.140	4.80	4.50	4.30
1075	40/80 W/W PET	.200	5.00	4.65	4.35
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1720	36/72 S/T	.200	3.30	3.10	2.90
1730	43/86 S/T Mot. 6800	.140	4.40	4.15	3.90
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DB51226-1A	2pc. Black Hood	1.40	1.30	1.20
DB110963-3	2pc. Grey Hood	1.35	1.25	1.15
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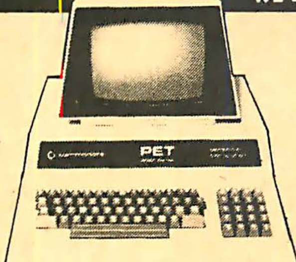
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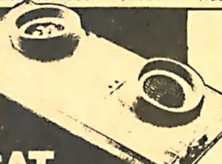
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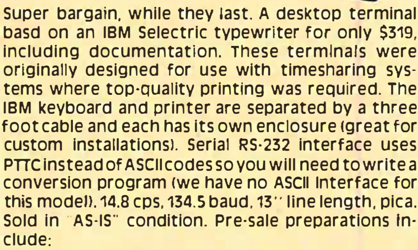
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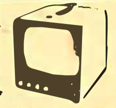
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26 cond. - .50/per foot
40 cond. - .75/per foot
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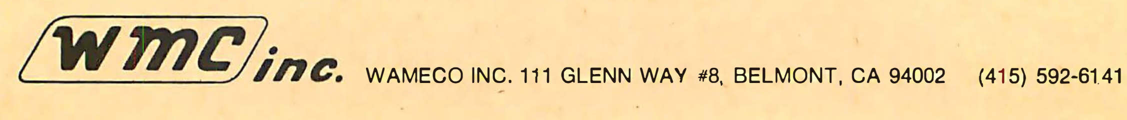
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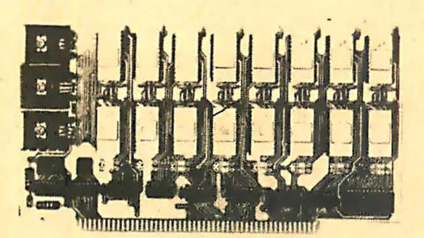
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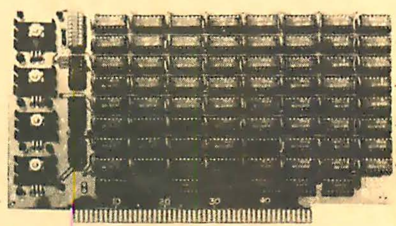
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WHY THE 2114 RAM CHIP?

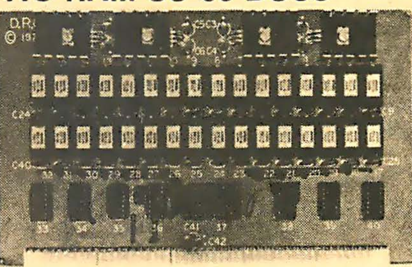
We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

KIT FEATURES:

1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 2 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

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16K STATIC RAM SS-50 BUSS



$295 KIT

FULLY STATIC AT DYNAMIC PRICES

KIT FEATURES:

1. Addressable on 16K Boundaries
2. Uses 2114 Static Ram
3. Runs at Full Speed
4. Double sided PC Board. Solder mask and silk screened layout. Gold fingers.
5. All Parts and Sockets included
6. Low Power: Under 2 Amps Typical

FOR SWTPC 6800 BUSS!

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16K S-100 Dynamic Ram Board - $149.95

ORIGINALLY PRICED AT $429 each!

We purchased the remaining inventory of PT's popular 16K Ram Board when they recently closed their plant. Don't miss the boat! These are brand new, fully tested, ASSEMBLED and ready to go. All are sold with our standard 90 day limited warranty!!

72 Page Full Manual, Included Free!

NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE SUPPLIERS OF CPM SOFTWARE.

Digital Research Computers
(OF TEXAS)

P.O. Box 401565 • GARLAND, TEXAS 75040 • (214) 494-1505

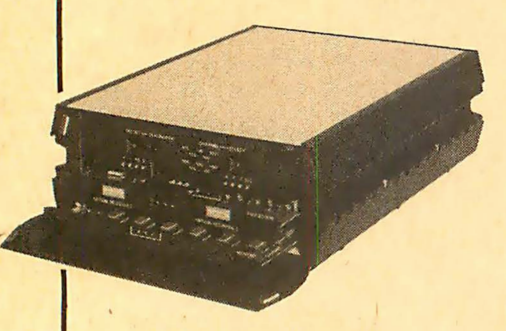
TERMS: Add 50¢ postage, we pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept Visa, MasterCharge, and American Express cards. Tex Res. add 5% Tax. Foreign orders (except Canada add 20% P & H. 90 Day Money Back Guarantee on all items.

Circle 100 on inquiry card.

What's New?

PERIPHERALS

Full Duplex Synchronous Intelligent Modem

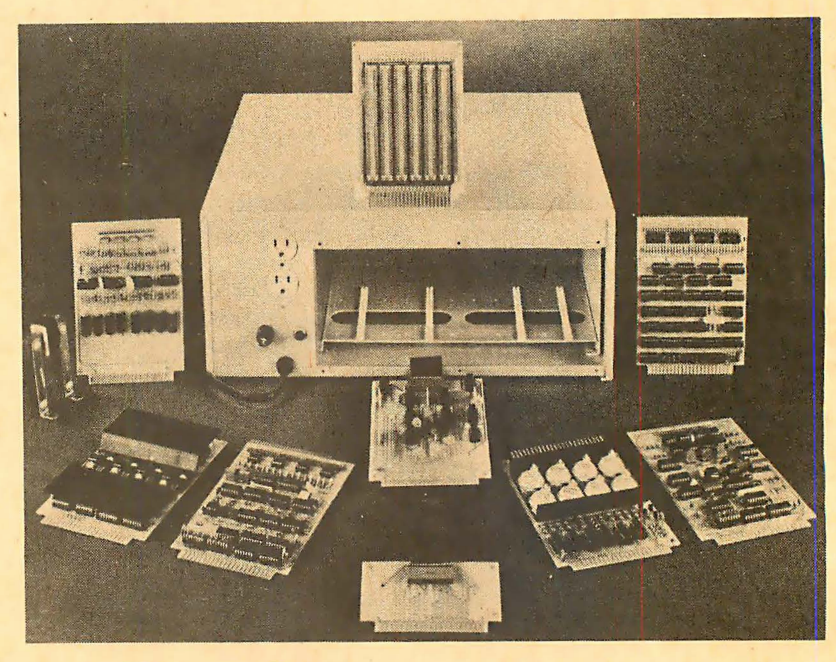


SuperModem transmits data thousands of miles at 9600 bits per second (bps) over unconditioned voice band data channels. By using an unconventionally low data rate it achieves a substantially higher tolerance to the transient noise-hits inherent in communication networks. It uses a transmitter that simultaneously generates a large number of individual carriers, modulating each to represent only a portion of the total data stream. The modem's receiver demodulates each carrier independently, and its data is combined with that from the other carriers to reconstruct the original data stream.

Three compact plug-in modules make up SuperModem: the program memory, 24-bit data processor, and the I/O (input/output) control. The program module includes a program built around algorithms which perform real-time analysis of the received signal. The 24-bit data processor uses pipeline architecture to attain an operating speed of 10 million instructions per second. It also is used to analyze circuit parameters while on-line and to perform diagnostic routines. Front panel controls provide the operator with mode selection, and enable configuration of the channel status indicators and the 3 digit diagnostic display.

For further information, contact Gandalf Data Inc, 1019 S Noel, Wheeling IL 60090.

Circle 589 on inquiry card.



General Purpose Data Acquisition and Process Control System

The Real World Interface System is a general purpose data-acquisition and process control system designed for use with mini and microcomputers. It features many different plug-in modules which give the user the flexibility and power to configure the system according to the user's needs. Applications include environmental control, peak demand limiting, robotics, and automated assembly line testing.

The unit has its own cabinet which includes a power supply, card cage, and motherboard with slots for up to 12 plug-ins. Each plug-in card has at least 8 channels of input or output (except for a maximum of 4 channels on the current probe), and some have 16 or even 32 channels.

All plug-ins can be purchased in either kit form or assembled and tested. The modules range in price from $65 a kit ($79.50 assembled) for the 8 channel DC controller card to $125 a kit ($150 assembled) for the 8 channel AC controller card. A cabinet, complete with motherboard, power supply, and parallel processor interface, is $299 for the kit ($360 assembled). For further information, contact General Computer Technology, 400 S Lipan, Suite 2, Denver CO 80223.

Circle 590 on inquiry card.

Voice Synthesizer for the TRS-80 Computer

The TRS-80 Voice Synthesizer is an accessory for Radio Shack's TRS-80 microcomputer system. It translates a computer output into recognizable, intelligible speech. The synthesizer includes a volume control, built-in speaker and cable assembly that permits easy plug-in connection to the TRS-80. Programming the TRS-80 for speech is done in BASIC. About 60 phonemes, representing units of speech, can be entered via the computer keyboard. This will even enable the computer to speak in foreign languages or with an accent, by integrating the various phonemes to produce the desired sounds. The voice synthesizer is especially useful in the field of education where it is used to supplement the displayed video information in a variety of learning situations such as spelling, reading, language arts, and mathematics.



The Radio Shack TRS-80 Voice Synthesizer is priced at $399 complete with detailed instruction manual and demonstration cassette. For further information, contact Radio Shack, 1300 One Tandy Ctr, Forth Worth TX 76102.

Circle 591 on inquiry card.



computer products, inc.

11542-1 KNOTT STREET
GARDEN GROVE, CALIFORNIA 92641
(714) 891-2663

MICROBYTE Z80/I-O

- A complete single board Z80A CPU and serial/paralle I/O system
- Fully S-100 Bus compatible, IMSAI, ALTAIR
- Z80A CPU (4 MHz version of the Z80)
- 158 Instructions — superset of and upward compatible from the 8080's 78 instructions
- Provision for up to 4K on board monitor program using 1K (2708), 2K (2716), 4K 2732
- On board EPROM can be hardware and/or software deselected
- 2 MHz or 4 MHz operation is switch selectable
- 0 or 1 wait state for all cycles is switch selectable
- 2 RS-232C serial ports with 8251 USARTs
- Serial baud rates switch selectable
- 24 programmable parallel I/O lines (uses 8255)
- Gold Contacts for higher reliability
- Power requirements: +8V @ 800mA, +18V, @ 86mA, −16V @ 100mA
- Operating temperature 0°-55°C
- Will operate with or without IMSAI/ALTAIR front panel
- Low power shottky tri-state buffers on all address and data lines
- Fully warranted for 120 days from date of shipment

$325.⁰⁰

IMSAI CONN.

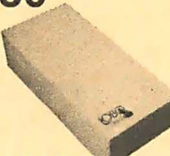
100 PIN-SOLDERTAIL
GOLD CONTACTS
$3.⁰⁰ each or 10/2.60 each

8251

PROGRAMMABLE/U-ART
TESTED @ 4 MHZ
$5.⁰⁰ each

TRS - 80

Floppy disk drive with cabinet & pwr. supply compatible with Radio Shack interface. Assembled & tested with 1 yr. warranty on parts & labor.
Mfg. by Lobo Drive



$385.⁰⁰

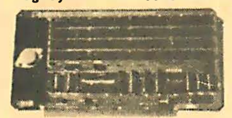
Interface Cable Available

SPECIAL

.1 @ 12 VOLTS
CERAMIC CAP
10¢ each
or
100 / $9.⁰⁰

MICROBYTE 16K STATIC RAM BOARD

- Fully S100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO
- Uses National's Low Power 5257 4K × 1 Static Rams
- 2 MHz or 4 MHz operation
- On board single 5 amp regulator
- Thermally designed heat sink (board operating temperature 0° — 70°C)
- Inputs fully low power Shottky Schmitt Trigger buffered on all address and data lines
- Phantom is jumper selectable to pin 67
- Each 4K bank addressable to any 4K slot with in a 64K boundary.
- 4K hardware or software selectable
- Selectable port address
- 4K banks can be selected or disabled on power on clear or reset
- Will operate with or without front panel
- Compatible with ALPHA MICRO, with extended memory management for selection beyond 64K
- No DMA restriction
- Low power consumption 1.3 amp
- Fully warranted for 120 days from date of shipment
- Extended addressing up to 1 megabyte of addressable ram



450 NS $320.⁰⁰
300 NS $340.⁰⁰

SHUGART 801-Disk Drive

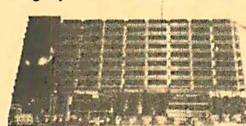
WITH CABINET & POWER SUPPLY
ASSEMBLED & TESTED
1 YR PARTS & LABOR
Mfg. by Lobo Drive
$585.⁰⁰
Dual Cabinet & Drives Available

2708's

LOW POWER
450 NS.
$8.⁷⁵ each
8 for $66.⁰⁰

MICROBYTE 32K STATIC RAM BOARD

- Fully S100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO
- Uses National's Low Power 5257 4K × 1 Static Rams
- 2 MHz or 4 MHz operation
- On board single 5 amp regulator
- Thermally designed heat sink (board operating temperature 0° — 70°C)
- Inputs fully low power Shottky Schmitt Trigger buffered on all address and data lines
- Phantom is jumper selectable to pin 67
- Each 4K bank addressable to any 4K slot with in a 64K boundary.
- 4K hardware or software selectable
- One on board 8-bit output port enables or disables the 32K in 4K blocks
- Selectable port address
- 4K banks can be selected or disabled on power on clear or reset
- Will operate with or without front panel
- Compatible with ALPHA MICRO, with extended memory management for selection beyond 64K
- No DMA restriction
- Low power consumption 2.3 — 2.5 amps
- Fully warranted for 120 days from date of shipment.
- Extended addressing up to 1 megabyte of addressable ram



450 NS $620.⁰⁰
300 NS $650.⁰⁰

SHUGART SA400

DISK DRIVE INCLUDES CABINET, NO PWR SUPPLY, CUTOUTS FOR SWITCH, FUSE, & INTERFACE CABLE
Mfg. by Lobo Drive
$325.⁰⁰

2716

5 VOLT ONLY
LOW POWER
450 ns
$40.⁰⁰

SCANBE / RN SOCKETS — LO PROFILE

(tin)

	1-24	25-99	100-499	500 up
14 PIN	.16	.15	.14	.12
16 PIN	.17	.16	.15	.14
18 PIN	.20	.19	.18	.16
20 PIN	.29	.28	.26	.25
24 PIN	.34	.32	.30	.28
40 PIN	.60	.58	.56	.52

REGULATORS

	1-9	10-49	50up
320 T-5	1.25	1.15	1.05
320 T-12	1.00	.90	.85
340T5	.75	.70	.65
340 T-12	.75	.70	.65
78 H05	6.00	5.70	5.40

MICROBYTE MOTHERBOARD

- Active Diode termination
- Slot for IMSAI front panel
- Terminal block connection for easy hook-up
- Extra wide ground plane
- Silk screen and solder mask
- Assembled and tested

9 slot kit $70.⁰⁰ A&T $100.⁰⁰
20 slot kit $125.⁰⁰ A&T $155.⁰⁰
Bare Board 9 slot $30.⁰⁰ 20 slot $50.⁰⁰

NEW PRODUCTS

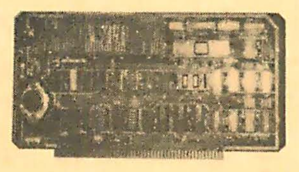
8086 — CPU BOARD
8088 — CPU BOARD
Double Density Controller
CALL OR WRITE
FOR DEALER INFO

CABLE ASSEMBLY

for 8" disk drives
(2) 50 PIN CARD-EDGE CONNECTORS ON 4ft. RIBBON CABLE
$20.⁰⁰ea.
extra conn. $7.⁰⁰ ea.

MICROBYTE DISK CONTROLLER

- IBM 3740 Soft Sectored Compatible
- Z80 or 8080 compatible on S-100 Bus
- Single density runs both mini and full size drives, runs CPM, on Shugart, Persci, Memorex etc.
- Selectable port/address
- On board 2708/2716 for bootstrap or monitor program
- No hardware jumpers, uses plug in modules for different drives
- Uses 1771B-01 controller chip
- Assembled and tested
- Specify disk drive used when ordering by mail



$225.⁰⁰

ORDERING INFORMATION:
Name, Address, Phone
Ship by: UPS or P.P.
Shipping Charge: Add $2.50 up to 5 lbs., all excess shipping charges will be refunded. Credit cards will be charged appropriate freight.

TERMS:
We accept cash, check, money orders, Visa, and Master Charge cards. (U.S. Funds Only).
COD's: on approval only
Open Acct's: companies may inquire for net terms.
Tax: add 6% for Calif. residents only

Circle 11 on inquiry card.

What's New?

SOFTWARE

Pascal for 6800 Processor

A new Pascal compiler is available which runs under the TSC Flex Version 1.0 operating system on a SwTPC 6800 system (or equivalent) with sufficient hardware. It is possible to compile and run Pascal programs in as little as 16 K bytes using a 5-inch floppy disk. The run-time system interfaces fully with Flex, permits user device handling, and includes a paging facility which is invoked automatically if there is sufficient real memory for a large program.

In a 32 K byte, 1 MHz clock frequency system with dual floppy disks, Pascal programs can be compiled at over 80 lines per minute. With 20 K bytes, compilation is at 35 lines per minute, under the paging mode of execution. The P-code generated by the compiler is compact and efficient, so that programs execute much faster than is possible with conventional interpreters.

The compiler is written in the subset of Pascal which it supports, and includes files, procedures, functions, recursion, sets, arrays, and CASE statements as well as the looping and branching constructs.

Release Version 1.0 of the Pascal compiler and P-code interpreter and run-time system are provided on a Flex Version 1.0 format 5-inch floppy disk. User documentation, useful utilities, and specimen programs are also supplied. Contact Lucidata (Pascal Div), Oosteinde 223, Voorburg 2271 EG (ZH), NETHERLANDS.

Circle 620 on inquiry card.

C Compiler for 8080 Microcomputer

A full C compiler for 8080-based microcomputer systems is available from Whitesmiths Ltd, 127 E 59th St, New York NY 10022. Provided with the compiler are a complete set of runtime support routines; the Whitesmiths Portable C Library, an interface library for operation of C under either CP/M or ISIS-II operating systems; and a translator for the narrative assembly language A-Natural.

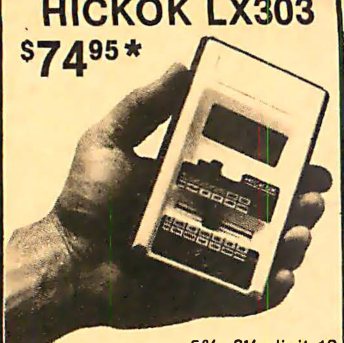
The 8080 compiler is currently available as a cross-compiler running on the PDP-11 under UNIX, RSX-11M, RT-11, RSTS/E, and IAS operating systems. Operating in three sequential passes, it produces A-Natural code, which is then translated to assembly language that is compatible with Intel's asm80 and Microsoft's Macro-80. Source code may also be written in A-Natural for processing by the same translator.

Owners of the Whitesmiths PDP-11 C Compiler will find that the 8080 implementation is highly compatible. Programs written using only the Portable C Library should run unchanged on the 8080, permitting extensive code checking on the PDP-11.

A standard cross-compiler package is available at a price of $700 for object code to be run on a single processor. This package includes the C compiler and PDP-11 support routines, the A-Natural translator, and the runtime library for use on a single 8080 processor. Use of the minimal machine-interface library on additional microcomputers is available for as little as $10 per processor.

Circle 621 on inquiry card.

HICKOK LX303 $74.95



HICKOK LX303

$74.95*

.5%, 3½ digit 19 Range DVM. ½" LCD displays runs 200 hrs on 1 battery. 10 Meg Ohm Input. 1 yr. guarantee, made in U.S.A., test leads included.

Available Accessories

- **RC-3** 115V AC Adapter $7.50
- **CC-3** Deluxe Padded Vinyl Carrying Case $7.50
- **VP-10** X10 DCV Probe Adapter/ Protector 10Kv $14.95
- **VP-40** 40Kv DC Probe $35.00
- **CS-1** 10 Amp Current Shunt $14.95

***FREE**

Just for Asking.
FREE BATTERY with your meter.

RS232 & "D" TYPE CONNECTORS

P = Plug-Male S = Socket-Female C = Cover-Hood

PART NO.	DESCRIPTION	PRICE 1-4	5-9	10-24
DE-9P	9 Pin Male	1.50	1.30	1.20
DE-9S	9 Pin Female	2.15	2.05	1.95
DE-9C	9 Pin Cover	1.50	1.30	1.15
DA15P	15 Pin Male	2.20	2.00	1.80
DA15S	15 Pin Female	3.20	3.00	2.80
DA15C	15 Pin Cover	1.60	1.45	1.30
DB-25P	25 Pin Male	2.90	2.60	2.50
DB-25S	25 Pin Female	3.75	3.65	3.40
DB51212-1	1 pc. Grey Hood	1.65	1.40	1.20
DB1226-1A	2 pc. Black Hood	1.90	1.60	1.50
DB110963-3	2 pc. Grey Hood	1.80	1.55	1.35
DC37P	37 Pin Male	3.95	3.80	3.60
DC37S	37 Pin Female	5.75	5.50	5.20
DC37C	37 Pin Cover	2.20	1.95	1.75
DD50P	50 Pin Male	4.95	4.75	4.50
DD50S	50 Pin Female	7.50	7.20	6.90
DD50C	50 Pin Cover	2.50	2.20	2.10
D20418-S	Hardware Set (2 pair)	1.00	.80	.70

MALE
FEMALE

Connector for CENTRONICS 700 SERIES:
Amphenol 57-30360 for back of Centronics 700 Series printers
1-4—$9.00 5-up—$7.50

3 LEVEL GOLD WIRE WRAP SOCKETS

Sockets purchased in multiples of 50 per type may be combined for best price.

	1-9	10-24	25-99	100-249	250-999
8 pin	.40	.36	.34	.31	.27
14 pin	.39	.38	.36	.34	.32
16 pin	.50	.42	.40	.36	.34
18 pin	.70	.60	.55	.50	.45
20 pin	.90	.60	.75	.65	.62
22 pin	.95	.65	.80	.70	.65
24 pin	.95	.65	.80	.70	.65
28 pin	1.25	1.15	1.00	.95	.90
40 pin	1.65	1.45	1.35	1.20	1.10

All sockets are GOLD 3 level closed entry. 2 level Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION.

SALE S-100 BUS EDGE CONNECTORS SALE

S100-WWG 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. GOLD PLATED.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STG 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR, IMSAI, CROMENCO motherboards GOLD plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

S100ALT 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .140 spaced rows for ALTAIR motherboards. GOLD plated.

1-4	5-9	10-24
$4.50	$4.25	$4.00

S100SE 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD

1-4	5-9	10-24
$5.00	$4.50	$4.00

Other Popular Edge Connectors

D2244-5SE 22/44Cont. .156 ctrs. PIERCED SOLDER EYELET tails. GOLD plated.

1-4	5-9	10-24
$3.00	$2.60	$2.20

D2244.5WW 22/44 Cont. .156 ctrs. WIRE WRAP tails. GOLD.

1-4	5-9	10-24
$3.95	$3.70	$3.40

CG-1 IMSAI Style Card Guides 5/$1.00

See our July Ad for many other connectors.

Vector APPLE PLUGBOARD

Vector 4609 Peripheral Interface Plugboard for construction of custom circuits. Plug compatible with Apple II, Commodore PET and Super Kim microcomputers. Three connectors, in addition to the standard 25/50 system bus, are available for input/output. A 20/40-contact card-edge connector, fabricated on the rear of the board, mates with a 3-M type ribbon connector. Alternatively, a right-angle solder-tail header may be positioned in this same location. The Model 4609 also accomodates the miniature SIP-type connectors which may be placed on the periphery or in mid-board.

1-4	5-9	10-24
$21.50	$19.36	$17.26

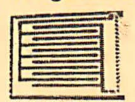
8803 Vector

MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations.
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads.
- Solder mask with solder windows on etched circuits to avoid accidental short circuits.
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion.
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations.
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise.
- Fits in Vector-pak enclosures.
- Fits in IMSAI 8080 microcomputer as expander board.

Price: $29.50

Vector Plugboards



8800V

Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5 3" x 10" x 1/16"

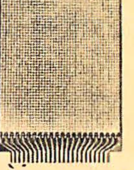
1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1

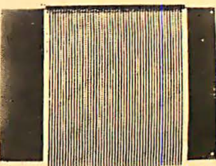
Same as 8800V except plain: less power buses & heat sink

1-4	5-9	10-24
$15.22	$13.79	$12.18

3682 9.6" x 4.5" **$12.97**
3682-2 6.5" x 4.5" **$9.81**
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156



3662 6.5" x 4.5" **$8.95**
3662-2 9.6" x 4.5" **$11.45**
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

3690-12
CARD EXTENDER
Card Extender has 100 contacts 50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems. $25.83
3690 6.5" 22/44 pin .156 ctrs. Extenders $13.17

1/16 Vector BOARD



.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
64P44XXXP	4.5x6.5"	$1.56	$1.40
169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
64P44	4.5x6.5"	$1.79	$1.61
84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.83	$7.94

TRS-80/APPLE MEMORY EXPANSION KITS

4116's RAMS
from Leading Manufacturers
(16Kx1 200/250ns)

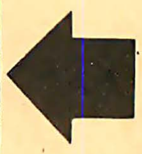
8 for $75.00

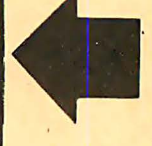
Add $3.00 for programming Jumpers for TRS-80 Keyboard

IC SOCKET SALE

14 pin Low Profile
10/$2.10 **100/$14.00**
16 pin Low Profile
10/$2.20 **100/$16.00**
24 pin Low Profile
3/$1.00 **40/$10.00**
40 pin Solder Tail
3/$1.00 **40/$10.00**
24 pin Dip Plug with cover
3/$1.00 **40/$10.00**

WOW 14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKES





14 - G3 100 for **$33.00**
16 - G3 100 for **$33.00**
50 of each for **$35.00**

PANAVISE

- P.C. BOARD HOLDER 315 — PRICE: $18.98
- 315–S same as 315 but with 14" bar to accomodate "S100" boards. PRICE $19.98
- LOW–PROFILE BASE 305 — PRICE: $13.49
- STANDARD BASE 300 — PRICE: $13.49
- STANDARD VISE HEAD 303 — PRICE: $14.49
- HORIZONTAL JAW VISE HEAD 304 — PRICE: $14.49
- VACUUM BASE 380 — PRICE: $18.49
- WIDE OPENING VISE HEAD 366 — PRICE: $14.49

VISE HEAD Swivels and Tilts; LOCK SCREW; BASE Swivels; 90; 360

PANAVISE TILTS, TURNS, AND ROTATES TO ANY POSITION. IT HOLDS YOUR WORK EXACTLY WHERE YOU WANT IT.

MEMORY MEMORY

2102LIPC Low Power 450ns in lots of 25	$1.10
2102AL-2 Low Power 250ns in lots of 25	$1.25
2114-3L 1Kx4 300 ns Low Power	8/$50.00
5257-3L 4Kx1 300ns Low Power	8/$50.00
2708 8K 450ns EPROM	$9.00
2716 16K 5 Volt Only EPROM	$45.00

LEDU



IM-10A List $89.00
SPECIAL
$56.95 with tube

Perfectly balanced fluorescent lighting with precision magnifier lens. Tough thermoplastic shade. Easy lens removal. New wire clip design permits easy installation and removal of fluorescent tube. Comes with plastic shield to protect tube from soiling and damage.
Colors: Gray, Black, and Chocolate Brown. Comes with one 22 watt T-9 Circline fluorescent tube. 3 diopter lens.

ORDER TOLL FREE

1-800-423-5633

except CA., AK., HI., Call (213) 894-8171

Vector WRAP POST

for .042 dia. holes (all boards on this page)
T44/C pkg. 100 .. $ 2.34
T44/M pkg. 1000 ..... $14.35
A-13 hand installing tool .... $ 4.19



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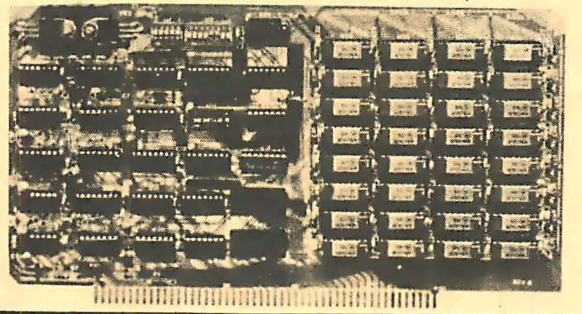
Circle 312 on inquiry card.

SD EXPANDORAM

The Ultimate S-100 Memory

The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisable on-board refresh, and IT WORKS!

- Interfaces with Altair, IMSAI, SOL-8, Cromenco, SBC-100, and others.
- Bank Selectable
- Phantom
- Power 8VDC, ± 16VDC, 5 Watts
- Lowest Cost Per Bit
- Uses Popular 4116 RAMS
- PC Board is doubled solder masked and has silk-screen parts layout.

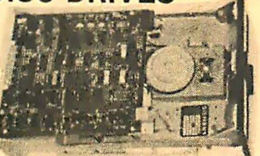


- Extensive documentation clearly written
- Complete Kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required.
- 16K boundries and Protection via Dip Switches
- Designed to work with Z-80, 8080, 8085 CPU's.

EXPANDO 64 KIT (4116)

16K	$249
32K	$324
48K	$399
64K	$474

DISC DRIVES



SHUGART SA 400 5¼"
110 KB, 35 tracks,
SHUGART SA 400 **$295.00**

SHUGART SA 400
with attractive metal case with cutouts for Data Cable switch, fuse and power cord.
LOBO SA400-C **$325.00**

SHUGART SA400
with Cabinet and Power Supply. Assembled, tested & guaranteed
LOBO SA400-PSC **$395.00**

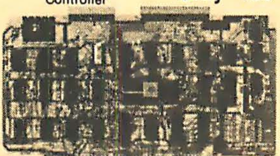
SHUGART 801R 8"
6.4 megabits, single or double density, hard or soft sector, write protect, and more
SHUGART 801R **$449.00**

Siemens FDD 200-8 8"
double-sided double density
$650.00

DISC CONTROLLER

SD "VERSAFLOPPY" Kit

The Versatile Floppy Disk Controller — Only $159^00



FEATURES: IBM 3740 Soft Sectored Compatible. S-100 BUS Compatible for Z-80or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:
1. Shugart SA400/450 Mini Floppy
2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
4. MFE 700/750.
5. CDC 9404/9406.
6. GSI/Siemans FDD120-8.

34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Comptier. The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. FD1771B-1 Single Density Controller Chip. Listings for Control Software are included in price.

CPM for SD Versafloppy $100^00

DUAL SHUGART DISC DRIVES

New from Lobo Drives, a dual Cabinet complete with power supply, and Shugart 801R disc drives.

- Cabinet accepts 2 801R drives mounted side by side horizontally.
- Power Supply for 2 drives
- Ad-on drives available
- Assembled, tested and guaranteed by Lobo Drives.
- Single or double density • Hard or soft sector • Write Protect
- Capacity: Unformatted single density 3.2 megabits
  double density 6.4 megabits
  IBM format, 2 megabits
- 500 KBS transfer, 77 tracks.
- Shugart 800 Series Compatible

LOBO 801R-1 Pcs. Dual Cabinet with 1 drive	**$599.00**
LOBO 801R-2 Pcs. Dual Cabinet with 2 drives	**$1025.00**
SHUGART 801R Ad-on disc drive	**$449.00**

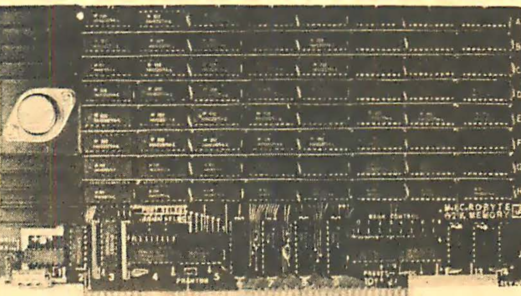
SAVE $120.00

THE MICROBYTE M32KSS 32K STATIC MEMORY BOARD

ASSEMBLED & TESTED
SALE PRICED

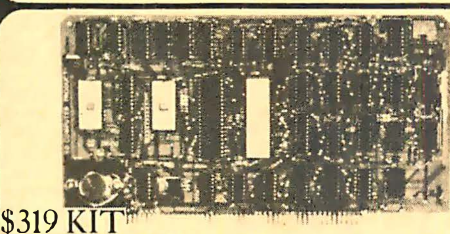
M32 KSS-L (2 MHz)
List $650 — SALE $530^00

M32 KSS-H (4 MHz)
List $680 — SALE $560^00



• Fully S100 Bus Compatible, IMSAI, SOL, ALTAIR, ALPHA MICRO. • Uses National's Low Power 5257 4K x 1 Static Rams. • 2 MHz or 4 MHz operation. • Gold contacts for higher reliability. • On board single 5 amp regulator. • Thermally designed heat sink (board operating temperature 0° — 70°C). • Commercially designed power bus, 7 ground bus bars, 0.1 uf decoupling capacitors. • Fully tri-state buffered. • Inputs fully low power Shottky Schmitt, Trigger buffered on all address and data lines. • Phantom is jumper selectable to pin 67. • Each 4K bank addressable to any 4K slot with in a 64K boundary. • 4K hardware or software selectable. • One on board 8-bit output port enables or disables the 32K in 4K blocks. • Selectable port address. • 4K banks can be selected or disabled on power on clear or reset. • Will operate with or without front panel. • Compatible with ALPHA MICRO, with extended memory management for selection beyond 64K. • No DMA restriction. • Low power consumption 2.3 — 2.5 amps. • Fully warranted for 120 days from date of shipment.

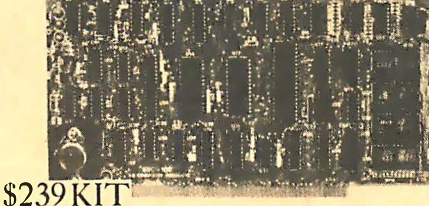
SD COMPUTER BOARDS



$319 KIT

VDB-8024 Video Display Board With On-Board Z80 Microprocessor

- Full 80 Characters by 24 lines display
- Characters displayed by High Resolution 7×10 Matrix
- Keyboard Power and Interface
- Composite Video Output
- Separate TTL Level Synchronization and Video Outputs
- 2K Bytes Independent On Board Memory
- On-Board Z80 Microprocessor
- Glitch Free Display
- 96 Upper and Lower Case Characters
- 32 Special Character Set
- 128 Additional user Programmable Characters
- Full Cursor Control
- Forward and Reverse Scrolling Capability
- Operates as an Independent Terminal
- Variable Speed Display Rate
- Blinking, Underlining, Field Reverse, Field Protect and Combinations



$239 KIT

SBC-100 Single Board Computer with On-board RAM, PROM, CTC

- Four Channel Counter/Timer (Z80-CTC)
- Software Programmable Baud Rate Generator
- S-100 Bus Compatible
- No Front Panel Required for Operation
- Optional Vectored Interrupts
- Z80 Central Processing Unit
- 1024 Bytes of Random Access Memory
- 8K Bytes of Available PROM
- Serial Input/Output Port with both Synchronous and Asynchronous Operation
- Parallel Input and Output Ports

$249

Z80 Starter Kit — A Complete Microcomputer on a Board

- Z80 Central Processing Unit with 158 Instructions
- On Board Keyboard and Display
- Kansas City Standard Cassette Interface
- PROM Programmer Built on-board
- Expansion provision for two S-100 Connectors
- Wire Wrap area for custom circuitry
- Single 5 Volt Operation when not programming
- 1K Bytes of RAM (Expandable to 2K Bytes)
- 1K Bytes of RAM (Expandable to 2K Bytes)
- 4 Channel Hardware Counter/Timer (Z80-CTC)
- Two Bi-directional 8-bit I/O Ports (Z80-PIO)
- Switch Selectable PROM or Monitor Restart
- 2K Byte ZBUG Monitor in ROM
- Memory Examine and Change
- Port Examine and Change
- Z80 CPU Register Examine and Change
- Up to 5 Programmable Breakpoints
- Single Step through RAM or PROM
- Audio Cassette Load and Dump
- Vectored Interrupts provided by Z80-CTC and Z80-PIO
- Ideal for Experimentation and Evaluating the Z80 CPU

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Prices subject to change without notice.
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phone orders welcome (213) 894-8171, (800) 423-5633

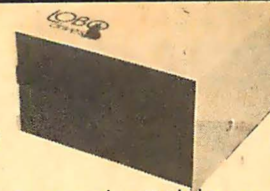
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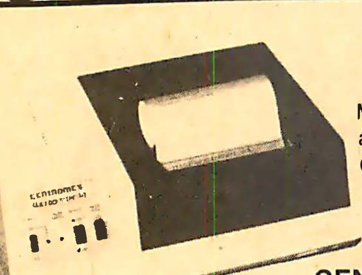
TRS-80 DISC DRIVE



$395.00

Shugart SA400, housed in an attractive metal case, complete with power supply and termination network. All you need to do is connect the drives to your expansion interface.

1410 $835.00



- Separate integral 12-key Numeric Pad
- All 128 ASCII Codes
- 64 Displayable Characters
- 24x80 Screen Configuration
- High Resolution using a 5x7 Dot Matrix
- TTY-Style Keyboard Layout
- Cursor Addressing and Sensing
- EIA Interface
- Eight Selectable Transmission Rates up to 9600 Baud
- Microprocessor Based
- Remote Commands
- Attractive Styling for Contemporary Environments

Hazeltine 1400 same as 1410 less numeric pad $735.00

1¢ SALE

buy a MICROPRINTER and get a CASE OF PAPER FOR 1¢. Reg. $25.00 value.

CENTRONICS® MICROPRINTER Nonimpact Desk-Top Printers

FEATURES

- 150 Lines Per Minutes
- 96 Characters — Upper and Lower Case
- 5/10/20 Characters/Inch — Software Selectable
- Elongated Characters
- Underlining
- Simplified Operation
- Quiet
- Audio Alarm
- Long Life — Only 4 Moving Parts
- Small Size and Light Weight
- No Toners/Ribbons Required

S1 Serial Interface Features $595.00

- 7-Bit ASCII, Serial RS232C Interface with Parity Selection
- Switch-Selectable Baud Rate: 50 to 9600
- 192 Character FIFO Buffer

P1 Parallel Interface Features $495.00

- 7-Bit ASCII
- TTL Compatible Input/Output Signals
- Compatible with Centronics and other Printer Product Lines

Centronics new compact MICROPRINTER is available in parallel and serial interface versions to satisfy a wide range of printer applications. The primary difference between the two models is the inclusion of an RS232C serial interface and 192 character FIFO buffer in the Model S1.

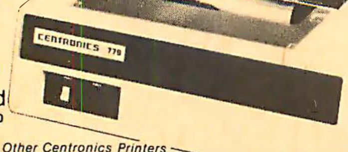
Both models employ nonimpact discharge technology that requires only four moving parts to produce variable pitch 5 x 8 dot matrix characters at a rate of 150 lines per minute — with exceptional clarity. The paper requires no toners or ribbons. Instead, it carries a conductive aluminized coating which is vaporized by a low voltage discharge from the print head to produce highly readable characters.





CENTRONICS 779 PRINTERS

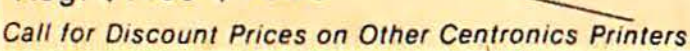
- Use with TRS-80
- Parallel interface
- Continuous variable printing density 80-132 characters per line
- 5x7 dot matrix
- Prints on plain paper, sheets, rolls, fan fold
- Form thickness control
- Horizontal and vertical form positioning



779-1 pinch roll friction feed Reg. $1250 **$950.00**

779-2 tractor feed Reg. $1400 **$1050.00**

Call for Discount Prices on Other Centronics Printers



Portable Miniscopes for Electronic Professionals on the Go!!!

The Standout Oscilloscope development of the decade!!! Now -30MHz, dual trace model. Compare the performance, then compare the price.



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• 30-Megahertz bandwidth • Accuracy 3% full scale. • Internal, line or external trigger. • Batteries and charger/transformer unit included • Graticule: 4x5 divisions, each division 0.25" • Time base: 1 micro sec. to 0.5 sec/div 21 settings • Verticle Gain: 0.01 to 50 Volts/div. 12 settings • Size 2.9"H x 6.4"W x 8.5"D. 3.5 lbs. • TEST MOST DIGITAL LOGIC CIRCUITS INCLUDING MICROPROCESSORS •

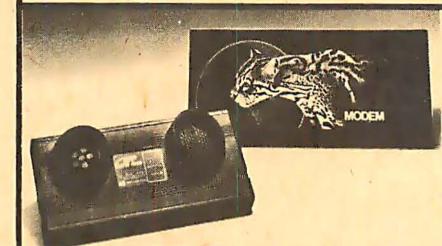
41-141	Deluxe 10tol probe with 4 interchangeable tips	**$27.00**
41-37	Deluxe 10tol/1tol probe with 4 interchangeable tips	**$38.50**
41-180	leather carrying case	**$45.00**
MS-15	Single trace 15 MHz	**$318.00**
MS-215	Dual trace 15 MHz	**$435.00**

3M Scotch® Brand DISKETTES

Part #	Sides/ Density	Sectoring	Price Box of 10
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740-OP	1/single	Soft-IBM	**$39.95**
740/2-OP	2/single	Soft-IBM	**$75.00**
740-32P	1/single	32-Shugart 801	**$39.95**
740/2-32P	2/single	32-Shugart 801	**$75.00**
741-O	1/double	Soft-Shugart Dbl	**$59.00**
		5"	
744-OK	1/single	Soft-Shugart SA400 (TRS-80)	**$51.00***
744-10K	1/single	Soft/10 SA400	**$51.00***
744-16K	1/single	Soft/16 Micropolis	**$51.00***

*Price Includes Kas-ette/10 Storage Box a $5.00 Value

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ACOUSTIC MODEM NOVATION CAT

- 0-300 Baud
- Bell 103
- Answer, Originate

Reg. $198.00

Sale $189.00

CONTINENTAL SPECIALTIES CORPORATION



100 MHz 8-Digit Counter



- 200 Hz-100 MHz Range
- 6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable - completely self contained
- Size - 1.75" x 7.38" x 5.63"
- Four power sources, i.e. batteries. 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply.

~~$134.95~~ **Sale $120.00**

ACCESSORIES FOR MAX 100: **Mobile Charter Eliminator** use power from car battery **Model 100-CLA $3.95. Charger/Eliminator** use 110 VAC **Model 100 — CAI $9.95**

CONTINENTAL SPECIALTIES CORPORATION CSC

SALE

REG. ~~$59.95~~

LOGIC MONITOR 1

Trace signals through all types of digital circuits. Unit clips over any DIP IC up to 16 pins. Each of its 16 contacts connects to a single-bit level detector that drives a high-intensity, numbered LED readout activated when the applied voltage exceeds a fixed 2 V threshold. Logic "1" turns LED on; logic "0" keeps LED off. A power-seeking gate network automatically locates supply leads and feeds them to the LM-1's internal circuitry. Saves minutes, even hours in design, troubleshooting, debugging of equipment. **Voltage Threshold:** 2 V ± 0.2 V. **Input Impedance:** 100,000 ohms. **Input Voltage Range:** 4-15 V max. across any two or more inputs. **Current Drain:** 200 mA at 10 V. **Size:** 4" l. x 2" w. x 1.75" d. when open. **Weight:** 3 ozs.

CSC Model LM-1 Logic Monitor—Complete. Sale Price **$54.95**

VISA · master charge

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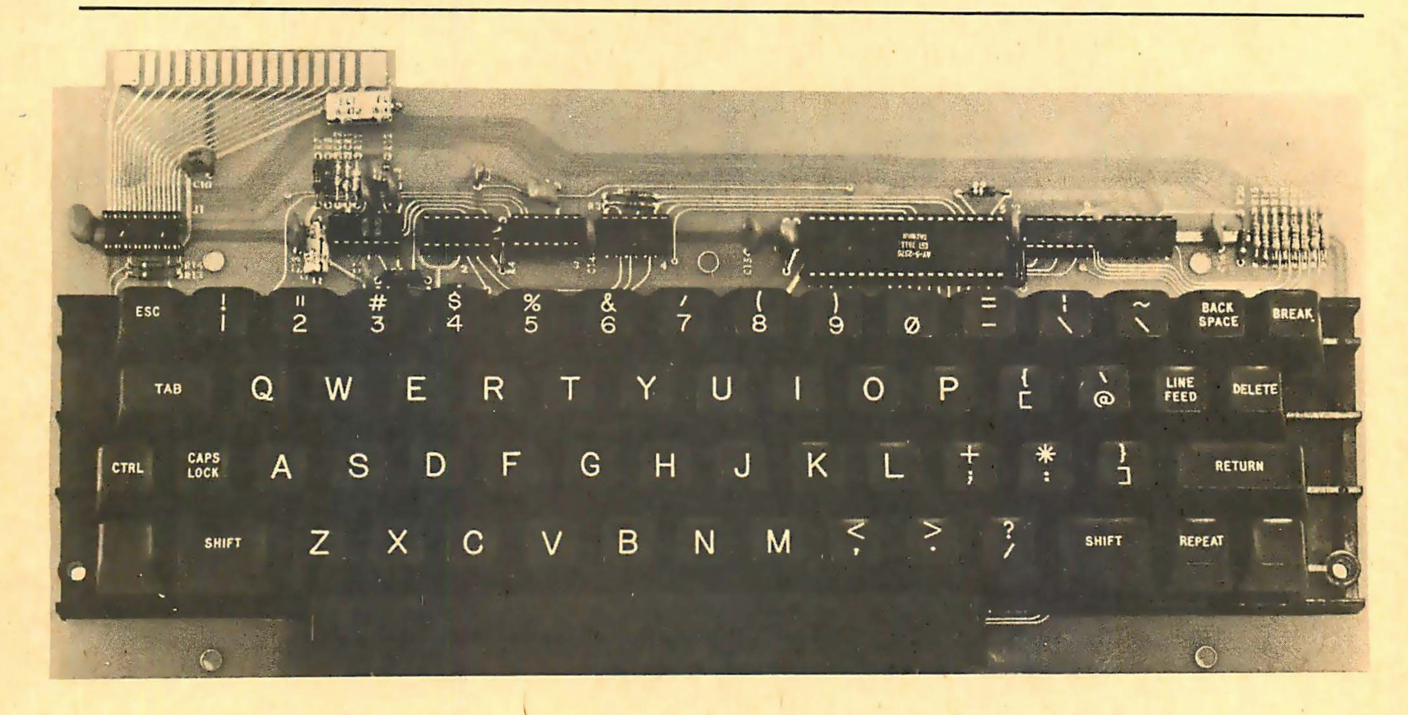
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The Jim-Pak News Herald

1021 Howard Street • San Carlos, California 94070 • (415) 592-8097

ANOTHER QUALITY  KIT ANNOUNCED!

SAN CARLOS, California (JE) — Jim-Pak Components today announced the addition of another innovative kit to their growing line of quality electronic kits for the home enthusiast. The JE610 62-key ASCII Encoder Computer Keyboard is now available through JIM-PAK distributors.



62-Key ASCII Encoder Keyboard Kit

THE JE610 62-KEY ASCII ENCODER KEYBOARD KIT CAN BE INTERFACED INTO MOST ANY COMPUTER SYSTEM. THE JE610 KIT COMES COMPLETE WITH AN INDUSTRIAL GRADE KEYBOARD SWITCH ASSEMBLY (62 KEYS), IC'S, SOCKETS, CONNECTOR, ELECTRONIC COMPONENTS AND A DOUBLE SIDED PRINTED WIRING BOARD. THE KEYBOARD ASSEMBLY REQUIRES +5V @ 150mA AND −12 V @ 10mA FOR OPERATION.

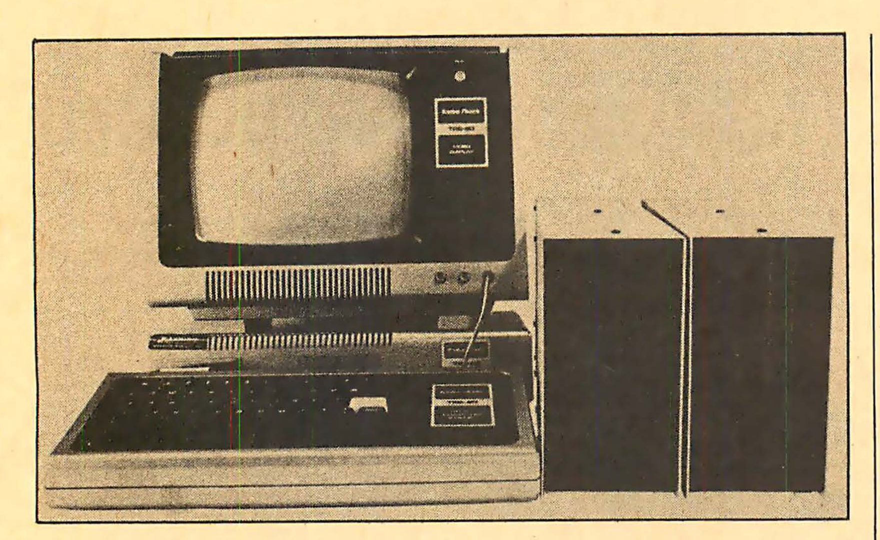
FEATURES:

- 60 KEYS GENERATE THE FULL 128 CHARACTERS, UPPER AND LOWER CASE ASCII SET
- FULLY BUFFERED
- 2 USER DEFINE KEYS PROVIDED FOR CUSTOM APPLICATIONS
- CAPS LOCK FOR UPPER CASE ONLY ALPHA CHARACTERS
- UTILIZES A 2376 (40 PIN) ENCODER READ ONLY MEMORY CHIP
- OUTPUTS DIRECTLY COMPATIBLE WITH TTL/DTL OR MOS LOGIC ARRAYS
- EASY INTERFACING WITH A 16-PIN DIP OR 18-PIN EDGE CONNECTOR

JE610

What's New?

PERIPHERALS



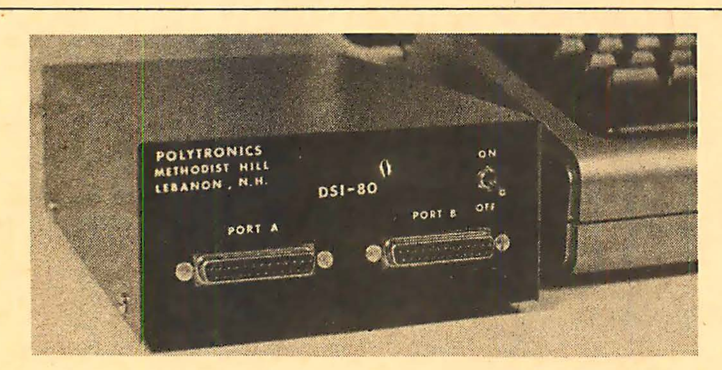
8-Inch Floppy Disk Drive for TRS-80 Computer

This Shugart 800-based floppy disk system, called Maxi-Disk, is fully compatible with existing TRS-80 5-inch floppy disk drives, and can be mixed and matched with smaller drives. The system plugs into the TRS-80 expansion interface. The user has only to remove the disk controller device from the expansion interface, and replace it with a specially designed circuit board. In this circuit board is a socket where the controller device is reinserted. All necessary parts and instructions are provided. No soldering or trace cutting is necessary.

The system also allows the user to use the expansion interface as it is designed since the only change is to turn the disk controller from a 5-inch only controller to an 8-inch and/or 5-inch controller.

The Maxi-Disk system sells for $995 which includes the 8-inch drive, the interface board, and a patch to the TRS-DOS that allows the user to access a variety of drives. For more information, contact Parasitic Engineering, POB 6314, Albany CA 94706.

Circle 608 on inquiry card.



Dual Serial Interface for TRS-80 Computer

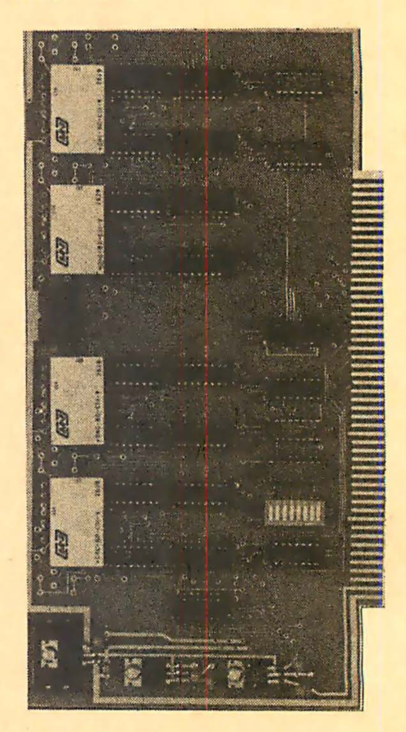
The DSI-80 is a dual serial interface for use with the Radio Shack TRS-80 computer. It provides 2 serial output ports with both current loop and RS-232 interface. Speed selections of 110, 150, 300, 600 and 1200 bits per second (bps) are accomplished by jumpers which require no special tools or soldering. The unit is built to MIL specifications and burned-in for a minimum of 120 hours before shipment. All integrated circuits are socketed and the timebase is crystal controlled.

The cassette tape provided with the DSI-80 contains several I/O (input/output) programs written in BASIC, intended to show how other BASIC programs can use the interface. The tape also contains system programs written in assembly language to patch the BASIC interpreter in the TRS-80, so that common time-sharing type terminals can be used to run BASIC and to receive output from the LPRINT AND LLIST commands.

The unit, complete with manual, cassette tape, and 6 month warranty is available for $199.95. For further information, contact Polytronics, Methodist Hill, Lebanon NH 03766.

Circle 609 on inquiry card.

S-100 Four Channel 12-Bit Digital-to-Analog Converter



The Tecmar S-100 D/A board is designed for applications requiring high-speed accurate digital-to-analog conversion including real-time applications. This board supports four independent high-speed digital-to-analog converters (DACs) with associated latches. Each DAC operates independently of the rest. The DACs have a conversion time of 3 μs which enables them to operate at maximum computer speed. A 12-bit latch drives the inputs of each DAC. Another 4-bit latch for each DAC holds the four new most significant bits waiting for the arrival of the new least significant byte. This allows the DAC to hold its previous value until an entire new word is presented to it. All the latches are set to zero by reset. To modify the contents of a latch, and hence the output of a DAC, it is necessary to send two bytes to the device. The input is a 12-bit in a two's complement format. The board may be addressed as I/O ports or memory mapped.

The S-100 D/A Converter Board is priced at $395 and comes complete with documentation; the S-100 D/A Technical Manual is $15. All boards are assembled and tested and have a 90-day warranty. For further information, contact Tecmar Inc, 23414 Greenlawn Ave, Cleveland OH 44122.

Circle 610 on inquiry card.

California Digital

Post Office Box 3097 B • Torrance, California 90503



Sankyo Magnetic Card Reader

$59

These Sankyo I/O units are capable of storing and retrieving over 400 characters of data in under two seconds.
The flexability of this device lends itself to numerous applications. As an input reader to a computerized security system, the computer has the ability of identifying the card holder and admitting only those individuals who are authorized to enter the premises during specified time frames. The device is also suitable for maintaining customer information files, or any other application where small amounts of information must be quickly entered into a data processing system.
Accepts 2" by 4" HP style mag-cards. (Similar to bank cards.)
Motorized feeder pulls the magnetic card across the four channel read/write head. NEW surplus, original cost $200. Full documentation

S-100 Mother Board

Quiet Buss™
$29.95
8803-18
18 slot
IMSAI

The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass

TELETYPE® MODEL 43

Even if we have to give them away, we're going to ship more 43's in 1979 than the aggregate of all our competitors.

Model 43AAA TTL)

EACH	3	10	25
$925.	875.	850.	825.

RS-232 Interface "K" Add $75.00 plus shipping

TELETYPE

HEXADECIMAL KEYBOARD

$34.95

Maxi-Switch hexadecimal keyboards are designed for microcomputer systems that require 4-bit output in standard hex code.

Each assembly consists of 16 hermetically sealed reed switches and TTL "one shot" debounce circuitry.

Reliable low friction acetal resin plungers are credited for the smooth operation and long life of this premium keyboard.

Requires single +5 volt supply.



FREE PLASTIC LIBRARY CASE with purchase of each box of .... Verbatim mini-diskettes. $5 value.

$29.95 BOX of 10

DISKETTES

CONNECTORS

your choice
DB25P male plug & hood
or
DB25S female
$3.95

Qty.	fe.	male	hd.
10	3.45	2.45	1.15
25	3.15	2.25	1.05
100	2.85	1.90	.95
500	2.25	1.60	.85
1K	1.97	1.37	.73

HOOD · MALE · FEMALE

Edge Connectors

GOLD
100 PIN
IMSAI/ALTAIR

Imsai solder .125x.250	$3.95	3/$ 9.00
Imsai w/w .125centers	$4.95	3/$13.00
Altair soldertail .140row	$5.95	3/$15.00
SPECIALS		
22/44 Kim eyelet .156"	$1.95	3/$5.00
25/50 solder tab .156"	$1.09	3/$2.00
36/72 wide post w/w .156	$1.95	3/$5.00



$24.88

SPERRY UNIVAC

KEYBOARD

The famous Sperry Univac 1710 Hollerith keyboard assembly is now available from California Industrial for only $24.88 The ideal computer input device for accountants and mathematicians. The numeric keys are placed on the lower three rows to resemble a ten key adding machine. This format allows one handed numeric data entry.
Original cost was $385. Used but guaranteed in excellent condition. Complete with documentation.

MODULATOR

$13.95



Assembled

The Atari R.F. Modulator allows computer data to be displayed directly upon your existing television system. This unit converts the signal from the Apple II and other video sources into television frequencies. Operates from single 5 volt supply. Complete with metal case, mating R.F. connector and 15 feet of coax cable. Schematics and instructions included.

SPECIAL

APPLE II
16K MEMORY
COLOR • GRAPHICS • SOUND
$1024 Mfg.Sug. Retail.... $1195
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TEN for $41
50+ $3.85

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DISKETTES
8inchSoft (IBM)
8inch 32sector
Mini Soft sec.
Mini 10 sector
Mini 16 sector

Certified Digital
CASSETTES
Won't drop a BIT!
$5.50



CALIFORNIA INDUSTRIAL is an Authorized Dealer of Scotch Brand Data Products

Shugart Associates

SA800-R Floppy Disk Drive

The most cost effective way to store data processing information, when random recall is a prime factor. The SA800 is fully compatible with the IBM 3740 format. Write protect circuitry, low maintenance & Shugart quality.

$449.50

$85 KEYBOARD ASCII ENCODED



KEYTRONIC ASCII & ASCII complement.
*Ten key data pad
*Cursor controls
*Six user switches
*Alpha Lock
*Auto repeat
*Single 5 volt.
*Glass reed.
NEW

MEMORY

TRS-80 APPLE II $65
16k memory (8) 4116's

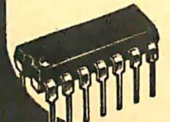
• As you may be aware, publishers require advertisers to submit their ad copy 60 to 90 days prior to "press" date. That much lead time in a volatile market place, such as memory circuits, makes it extremely difficult to project future cost and availability.
To obtain the best pricing on memory we have made volume commitments to our suppliers, which in turn affords us the opportunity to sell these circuits at the most competitive prices. Please contact us if you if you have a demand for volume state of the art memory products.

STATIC	1-31	32-99	100-5C	-999	1K+
21L02 450nS.	1.19	.99	.95	.90	.85
21L02 250nS.	1.49	1.39	1.25	*	*
2114 1Kx4 450	5.95	5.50	5.25	4.75	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

SPECIAL CIRCUITS

Z80A 4 MHz.	24.95	AY5-1013A UART	4.95
8080A CPU	9.95	Floppy Disc Controllers	
8085	22.50	WD 1771 single D.	39.95
8086 Intel 16 bits	*	WD 1781 Double D	65.00
TMS 9900 16 bits	49.95	WD 1791 D/D 3740	*

EPROMS		1-15	16-63	64+
1702A	2K	4.95	4.50	4.00
2708	8K	9.95	9.50	9.00
2716 5v	16K	39.95	35.00	*
2716 TI		24.88	20.00	*
2532		*	*	*





$139.50

PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for chain store inventory control and order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered into the recorder, the main warehouse is telephoned, the handset is placed in the acoustic coupler and all the recorded information is transmitted back to the master computer. With a little imagination and one of these portable entry systems, you should be able to exchange programs and computer information with associates across the country. All units were removed from service in working condition. Original cost $2,500.
Each system comes complete with:

- Portable Cassette Drive Unit
- Removable Entry Keyboard with LED Display
- Five Gould "D" NiCads
- Acoustical Coupler
- Battery Charger
- DB25 Cable
- Shoulder starp
- Full Documentation

MINIATURE SWITCHES

your choice

$.98

10	50	100	1k
$.88	.81	.73	.66

SPDT Miniature Toggles

7101C&K	ON-NONE-ON
7107 jbt	ON-OFF(mnt.ON)
7108 CK	ON-(moment. ON)
Rocker JBT	DPDT
Rotary	3P-4-Pos.
Rotary	3P-6-Pos.
Push B (N.O.)	$.39ea. 4/$1

DIP Switch

$1.49 ea.

10	25	100	1K
$1.29	1.15	.97	.83

specify 4 7 or 8 pos.
SPST

SYSTEM X·10

It's not offen that California Digital ventures into the distribution of consumer products, but we have resently come accross a product that appears so unique that we just had to add it to our product line. This is the System X-10 manufactured by the BSR turntable company. This space age system will remotely control any light or appliance in your home or office. Command signals are transmitted from the command console over your existing wiring. From your bed or easy chair you can control up to 16 different electrical devices inside and outside your home. Use the System X-10 to control your stereo, television or any light fixture on the premises.

The basic sampler package comes complete with command console, battery operated ultrasonic controller, one each of the appliance module, lamp module and wall switch. The basic package is priced at only $99.50 Additional modules are available for $13.95 each.

DISCOUNT Wire Wrap Center

IC SOCKETS

pin	wire wrap ea.	25	50	low profile ea.	25	50
8	—	—	—	17¢	16	15
14	37¢	36	35	18	17	16
16	38	37	36	19	18	17
24	99	93	85	36	35	34
40	169	155	139	63	60	58

KYNAR WIRE WRAP
50ft. $.98

500	1,000	11,000
$9.	$15.	$105.



wire wrapping



$29.95
BW 630

OK HOBBY WRAP-30 wire wrap & strip tool
$5.45

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All merchandise sold by California Digital is premium grade. Sorry, no COD's. Orders are shipped the same day received. California residents add 6%. Foreign orders add 10%. Orders over $25, when accompanied by payment, are shipped at our expense. Otherwise, please add $2.





Circle 39 on inquiry card.

JADE Computer Products

JADE'S NEW MAINFRAME
THE PIGGY IS HERE!

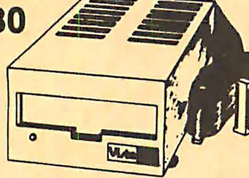


This sleak new mainframe is beautifully designed around JADE'S six slot **ISO-BUS** motherboard and an 18 amp power supply with provisions for up to 3 mini-floppy drives. This is a practical, state-of-the-art design whose looks just can't be beat! **ENS-106320** (without drives) **$475.00**

VISTA V80



TRS-80 MINI-DISK SYSTEM



The **V80** out-performs standard Radio Shack drives!--23% more storage capacity, 8 times faster access time, more reliable, and much less expensive. Includes disk drive, power supply, regulator board, and case. **MSM-358000 $395.00**
Interface cable for V80 **WCA-3421** **$24.95**

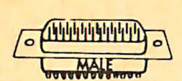
DISKETTE SPECIAL

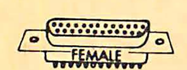
5.25" SOFT, 10, OR 16 SECTOR
10 for $29.95
8" SOFT SECTOR IBM COMPATIBLE
10 for $34.95

S-100 CONNECTOR SALE

100 PIN IMSAI TYPE SOLDER-TAIL CONNECTOR

6 for $17.50 **12 for $29.95**





RS-232 SET SPECIAL $6.50

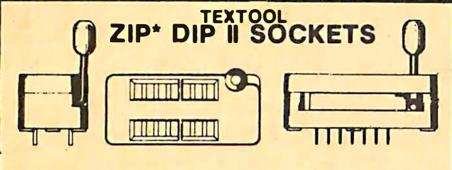
DB-25S, DB-25P, DB-25 COVER

DB-25S (FEMALE) **$3.65**
DB-25P (MALE) **$3.15**
DB-25C (COVER) **$1.50**

SPST DIP SWITCHES

PART NUMBER	NUMBER OF SWITCHES	PRICE
SWD-103	3	$1.18
SWD-104	4	$1.20
SWD-105	5	$1.24
SWD-106	6	$1.28
SWD-107	7	$1.30
SWD-108	8	$1.34
SWD-109	9	$1.36
SWD-110	10	$1.38

TEXTOOL ZIP* DIP II SOCKETS



16 PIN ZIP* DIP II ... **$5.50**
24 PIN ZIP* DIP II ... **$7.50**
40 PIN ZIP* DIP II .. **$10.25**
*** ZERO INSERTION PRESSURE**

JADE'S NEW INTELLIGENT CONTROLLER
THE DOUBLE-D

Read/write in single or **double density.**
8" or 5¼" drives.
CP/M compatible in either single or double density.
On-board Z-80 CPU allows universal compatibility.
Programmed data transfer. **No DMA.**
Controls up to 8 drives.
Software selectable density.
Our new controller utilizes the IBM standard formats for proven reliability. Data recovery is enhanced through the use of a phase-locked-loop data separation circuit and write precompensation. Single and double density disk drives can be mixed in the same system.

KIT **$285.00**
ASSEMBLED & TESTED **$349.00**
BARE BOARD with MANUAL **$55.00**
MANUAL **$10.00**

SD SYSTEMS VERSA-FLOPPY

KIT **$159.95**
ASSEMBLED & TESTED **$239.00**

TARBELL FLOPPY DISK INTERFACE

JADE KIT **$190.00**
ASSEMBLED & TESTED **$260.00**

FLOPPY DISK SPECIAL

TWO SIEMENS 8" DISK DRIVES
JADE DOUBLE-D CONTROLLER KIT
POWER SUPPLY FOR DRIVES
CP/M OPERATING SYSTEM W/BASIC-E
BOX OF 10 DOUBLE DENSITY DISKS
INTERFACE CABLES---A $1594.95 VALUE.
JADE SPECIAL $1225.00

FLOPPY DISK DRIVES

NEW BASF MINI-FLOPPY **$319.95**
Shugart SA400 compatible but only two-thirds the size! 40 track, double density 5¼" drive. Very low power consumption!

MPI B51 5¼" DRIVE **$295.00**
Single or double density, up to 40 tracks, track-to-track access time of 5ms, Shugart SA400 compatible.

MPI B52 5¼" DRIVE **$450.00**
Double-sided version of MPI B51.

SHUGART SA400 5¼" DRIVE **$325.00**
Single density, 35 track.

SIEMENS FDD100-8 8" DRIVE **$495.00**
Certfied double density Shugart 801R replacement.Runs much cooler and quieter.

SIEMENS FDD200-8 8" DRIVE **$575.00**
Double-sided, double density version of FDD100-8.

SHUGART 801R 8" DRIVE **$575.00**
Hard or soft sectored, 400K byte drive.

PERSCI 277 DOUBLE 8" DRIVE **$1595.00**
Limited quantity with slim line case & power supply.

POWER SUPPLIES

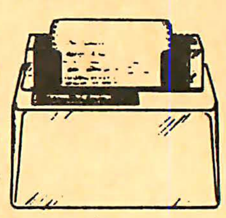
For a single 5¼" disk drive.
PSD-249A **$52.00**
For a single 8" disk drive.
PSD-205A **$89.95**
For two 8" disk drives.
PSD-206A **$125.00**
For Rockwell AIM-65.
PSX-030A **$59.95**
For KIM-1 or SYM-1.
PSX-020A **$59.95**

CP/M 2.0

Digital Research has done it again! This new release of their industry standard disk operating system is bound to be an even bigger hit than the original version. All of the fundamental file-size restrictions of release 1 have been eliminated, while maintaining full compatibility with the earlier versions. This new release can be field-configured by the user for a single mini-disk up through a multiple drive hard-disk system with 128 megabyte capacity. Field configuration can be accomplished easily through use of the Macro Library (DISKDEF) provided with CP/M 2.0.

A powerful operating system for only ... **$150.00**

INTEGRAL DATA SYSTEMS MODEL 440 PRINTER
THE PAPER TIGER



Up to 198 CPS
1.75 to 9.5 inch adjustable tractor feed.
Parallel and serial interface.
98 character ASCII set
132 columns- 6 or 8 lines/inch
Eight software selectable character sizes.
110, 300, 600, 1200 baud.
PRM-33440 .... **$995.00**
For the **Graphics Option** with **2K Buffer** add $199.00

JADE JP80-T PRINTER
HARD COPY......EASY PRICE!

JADE is proud to announce the low-cost solution to your hard copy needs. The JADE JP80-T printer is a high quality 80 column dot matrix printer with an adjustable width tractor feed mechanism. We are certain that you can not get a better printer in this price range!
FAST-150 cps print speed, 80 columns per line.
VERSATILE-adjustable tractor feed 2" to 10".
Upper and lower case 96 character ASCII set.
5 X 7 dot matrix with software selectable character widths.
Centronics-type parallel interface.
Interface/cables available for most popular microcomputers.
PRM-27081 .... **$749.95**

CENTRONICS 730 PRINTER
THE ANY-PAPER PRINTER

This printer can use roll paper, fanfold paper, or single sheets because it is equipped with both friction feed and pin feed mechanisms.
RS232 or parallel interface.
96 ASCII character set, upper and lower case.
80 characters per line, 7 X 7 dot matrix.
50 cps print speed.
Weighs less than 10 pounds!
PRM-15730 .... **$950.00**

EXIDY SORCERER

FREE **12 INCH B & W MONITOR WITH EVERY 16K SORCERER**

Flexibility is the key. The Sorcerer Computer gives you the flexibility of using ready-to-run, pre-packaged programs or doing your won thing and personalizing the programs for yourself. Which ever you choose. The Sorcerer is the personal computer that speaks your language.

The Sorcerer also provides full graphics capabilities. Each character formed by an 8 x 8 dot cell, can be programmed as a graphic symbol set. High resolution (512 x 240 addressable points) gives a total of 122,880 locations for super animation and extremely light plotting curves. The alphanumeric set gives 64 x 30 characters on the video screen.
With 16K of memory **$1150.00**

LEEDEX MONITOR $139.00

- **12" Black and White**
- **12 MHZ Bandwidth**
- **Handsome Plastic Case**

JADE DISK CABLES

MINI-DISK CABLE KIT--Connects two 5¼" mini-floppies to your disk controller board and power supply. Includes 5' signal cable with three 34 pin edge connectors, plus power supply connectors and cables. **WCA-3431K** **$34.95**

SIGNAL CABLE ONLY--Connects one 5¼" drive to edge type controller card. **WCA-3421A** .. **$24.95**
For two 5¼" drives. **WCA-3431A** **$29.95**

8" DISK CABLE KIT--Connects two 8" disk drives to edge type controller card such as the **Versafloppy** and **Double D**. Includes 5' signal cable with three 50 pin edge connectors, plus power supply cables and connectors. **WCA-5031K** **$38.45**
8" DISK CABLE KIT--Same as WCA-5031K except controller end of signal cable has a pin type connector such as the **Tarbell** controller. **WCA-5032K** **$38.95**

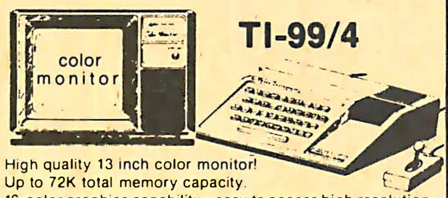
Circle 195 on inquiry card.

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TEXAS INSTRUMENTS

TI-99/4



High quality 13 inch color monitor!
Up to 72K total memory capacity.
16-color graphics capability - easy to access high resolution graphics have special features that let you define your own characters, charts, graphs, etc.
Music and sound effects - build three-note chords and adjust frequency, duration and volume quickly and simply. Five full octaves. Built-in equation calculator—Unique convenience feature helps you find quick solutions to everyday math problems, as well as complex scientific calculations.
Programs are sealed securely in SOLID STATE SOFTWARE COMMAND MODULES. These ROM pack acctually add memory to the TI-99/4 so that the console's memory can be utilized for user input. **SYO-8994A $1150.00**

SD SYSTEMS
Z-80 STARTER KIT

Based on the powerful Z-80 CPU, this kit is an ideal introduction to microprocessors. It has an on-board keyboard and display, plus cassette tape interface, and expansion provisions for two S-100 connectors. This "Do-it-all-Board" will also program the 2716 2K

Kit $249.95
Assembled and tested $439.00

SD SYSTEMS
SBC-100

An S 100 single board computer. Z 80 CPU with 1024 bytes of RAM 8-32K bytes of PROM Serial I/O port.

Kit $239.95
Assembled $369.95

Solid State Music
I/O 4

2 Serial and 2 Parallel I/O.
Ports S 100 with full hand shaking.

JADE Kit $149.95
Assembled $199.95
Bare Board $29.95

PARALLEL/SERIAL INTERFACE

S-100 compatible, 2 serial I/O ports, 1 parallel I/O.

Kit $124.95
Assembled & Tested $179.95
Bare Board W/ Manual $30.00

PROTO BOARD

Includes gold plated fingers. S-100 size, holds 72-16 pin dips, accomodates all 8 thru 40 pin dip packages. Reg. 19.95
TSXA-140B $16.95

SYM-1

6502- Based single board computer with keyboard/display. KIM 1 hardware compatible, complete documentation.
SYM-1 CPK-5002A $245.00
SYM-1 CASE, ENX-000005 .... $39.95

JADE'S NEW MOTHERBOARDS
THE ISO-BUS

The only motherboard availible today that is designed to IEEE S-100 Bus Standards--a unique network theory of design in which each signal line is surrounded by current mirrored ground lines, significantly reducing RF radiation virtually eliminating crosstalk. No need for active termination. The perfect foundation for a 4MHz system.

6-SLOT
BARE BOARD $24.95
KIT $49.95
ASSEMBLED & TESTED $59.95

12-SLOT
BARE BOARD $39.95
KIT $89.95
ASSEMBLED & TESTED $99.95

18-SLOT
BARE BOARD $59.95
KIT $129.95
ASSEMBLED & TESTED $149.95

JADE
MEMORY EXPANSION KITS
FOR
TRS-80 APPLE EXIDY

Everything you need to add 16K of memory to your computer. Your kit comes neatly packaged with easy to follow instructions. In just minutes your computer is ready to tackle more advanced software.

$82.00

THE BIG Z
THE NEW Z-80 CPU BOARD FROM JADE

Features include ● S-100 Compatible available in 2MHz or 4MHz versions. ●On-board 2708, 2716, or 2532 EPROM can be addressed on any 1K, 2K or 4K boundary with power-on jump to EPROM. ● On-board EPROM may be used in SHADOW mode, allowing full 64K RAM to be used. ● Automatic MWRITE generation in front panel is not used. ●On-board USART for synchronous or asynchronous R232 operation (on-board baud rate generator). ●Reverse channel capability on USART allows use with buffered peripherals or devices with not-ready signal.

2MHz Kit: CPU-30200K. 2lbs $149.95
Assembled and Tested CPU 30200A 2lbs. $199.95
4MHz Kit: CPU-3020 1K. 2 lbs. $159.95
Assembled and Tested CPU-30201A. 2lbs. $209.95

MICROPROCESSORS	
F8	$18.95
Z80 (2MHz)	$10.95
Z80A (4MHz)	$14.95
CDP1802CD	$24.95
6502	$11.95
6800	$12.50
6802	$20.00
8008-1	$15.95
8035	$24.00
8035-8	$24.00
8080-A	$10.00
8085	$23.00
TMS9900TL	$49.95
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8212	$5.00
8214	$4.65
8216	$2.95
8224 (2MHz)	$4.30
8226	$2.75
8228	$6.40
8238	$6.40
8243	$8.00
8251	$7.50
8253	$20.00
8255	$6.40
8257	$19.95
8259	$19.95
8275	$69.95
8279	$17.70
USRT	
S2350	$10.95
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AY5-1013A	$5.25
AY5-1014A	$8.25
TR1602B	$5.25
TMS6011	$5.95
IM6403	$9.00
BAUD RATE GENERATORS	
MC14411	$10.00
14411 Crystal	$4.95

6800 PRODUCT	
6821P	$5.25
6828P	$12.00
6834P	$16.95
6850P	$4.80
6852P	$7.50
6860P	$9.25
6862P	$12.00
6875L	$7.30
6880P	$2.50
CHARACTER GENERATORS	
2513 Upper	$7.95
2513 Lower	$6.75
2513 Upper (5 volt)	9.75
2513 Lower (5 volt)	$13.00
MCM6571 up scan	$13.00
MCM6571A down scan	$10.95
PROMS	
1702A	$5.00
2708	$12.95
2716	$49.00
2716 (5v)	$49.00
2758 (5v)	$30.00
DYNAMIC RAMS	
4116/416D (200ns)	$12.95
2104/4096	$4.75
2107B-4	$3.95
TMS4027/4096	$4.75
STATIC RAMS	
21L02 (450ns)	$1.50
21L02 (250ns)	$1.75
2101-1	$2.95
2111-1	$3.25
2112-1	$2.95
2114L (450ns)	$8.00
2114L (300ns)	$9.00
TMS4044 (450ns)	$8.00
TMS4044 (300ns)	$9.95
410D (200ns)	$9.95
4200A (200ns)	$9.95
MM5257 (450ns)	$8.00
MM5257 (300ns)	$9.95

JADE maintains an inventory of over 4000 line items, for price and delivery on items not listed (including hard to find 74LS devices!) please give us a call.

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Computer Products

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ROCKWELL AIM-65
THE HEAD-START IN MICROCOMPUTERS

A KIM-1 COMPATIBLE MACHINE WITH ON-BOARD PRINTER AND A REAL KEYBOARD!
AIM-65 w/1K of RAM $375.00
AIM-65 w/4K of RAM $450.00
8K BASIC in ROM $100.00
4K Assembler/Editor $80.00
Power Supply $59.95
Case of AIM-65 $49.95

Special Package Price $599.00
4K AIM-65, 8K BASIC ROM, Power Supply, and Case.

SD SYSTEMS
EXPANDORAM
Expandable to 32K or 64K

EXPANDO-32K KITS
Uses 4115 (8K X 1,250ns) Dynamic RAMs. Can be expanded in 8K increments up to 32K

8K $159.95
16K $199.95
24K $249.95
32K $299.95

EXPANDO-64K KITS
Uses 4116 (16K X 1, 200ns) Dynamic RAMs. Can be expanded up to 64K in 16K increments.

16K $249.95
32K $369.95
48K $469.95
64K $569.95

STATIC RAM BOARDS

8K 2MHz KIT $125.95
8K 2MHz ASSEMBLED & TESTED $175.00
8K 4MHz KIT $149.95
8K 4MHz ASSEMBLED & TESTED $180.00
8K BARE BOARD & MANUAL $25.00
16K 2MHz KIT $250.00
16K 2MHz ASSEMBLED & TESTED $325.00
16K 4MHz KIT $285.00
16K 4MHz ASSEMBLED & TESTED $350.00
16K BARE BOARD & MANUAL $35.00
32K 2MHz KIT $539.95
32K 2MHz ASSEMBLED & TESTED $650.00
32K 4MHz KIT $619.95
32K 4MHz ASSEMBLED & TESTED $675.00

SD SYSTEMS
VDB-8024

An **80 by 24** I/O mapped video board for S-100 systems. An on-board Z-80 processor is used to control all functions. A total of 256 user-programmable characters are available, including 128 characters that are supplied with the board. **This is virtually a stand-alone terminal!**
KIT $319.95
ASSEMBLED AND TESTED $469.95

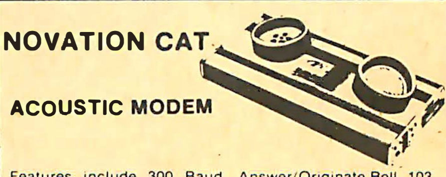
JADE VB-1B

This 64 by 16 memory-mapped video board is ideal for use with word processing software such as the Electric Pencil.
KIT $127.50
ASSEMBLED AND TESTED $169.95
BARE BOARD/MANUAL $35.00

VECTOR GRAPHICS
FLASHWRITER II

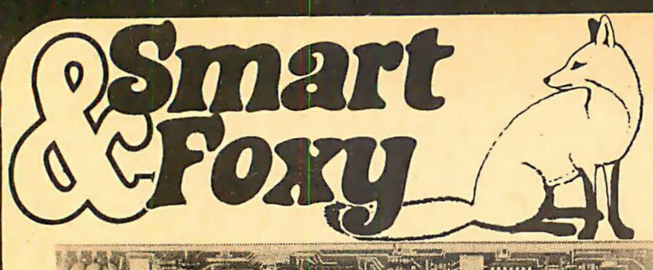
The ultimate memory-mapped 80 character by 24 line video board, the Vector Graphics FWII has many advanced features: Onboard parallel keyboard port, Power-on jump circuit, 8 X 10 dot character matrix, and the optional ability to program your own characters and/or graphics symbols. this is THE perfect board for text editing systems.
ASSEMBLED AND TESTED $320.00

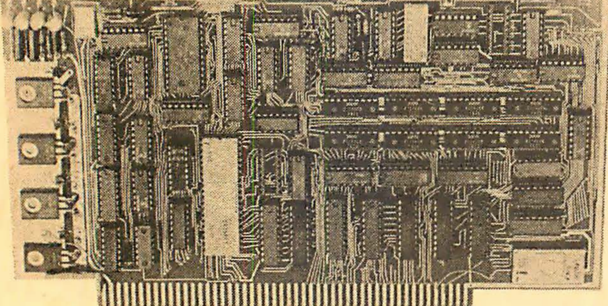
NOVATION CAT
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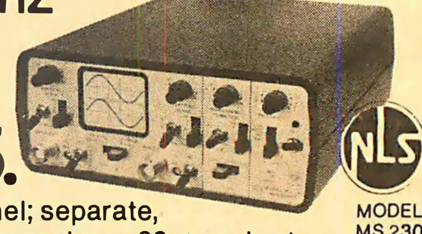
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FOR SALE: Heath H8 with 8 K memory, H9 video terminal, two H8-5 cassettes, BASIC and other tapes. $900 or best offer. Bob Stevenson, 414 E 78th St, New York NY 10021.

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